Hovedoppgave for oecon-graden

Economic Convergence

The East Asia Evidence

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Preface

Economists have, in some sense, always known that growth is important. For me as many others not only economic growth but also diminishing significant gap between different economies in the world have been important.

Economic growth theory, i.e., neoclassical model simply predicts that each country eventually become as rich as all the others, the cross-section dispersion diminishing over time.

For examining such problem, one need both theoretical and empirical analysis. Hence, in this paper, I have attempted to answer some questions in this case, with evidences from East Asia. How much I have achieved to my aim, you can judge it.

Here, I want to thank my supervisor Professor Tor Jakob Klette for his guidance and very useful advices. I also thank our professors and other personals in Economic Institute who have made an instructive environment for the students.

A. Joian

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1. Introduction

There is no doubt that East Asian countries have had a very successful economic growth in last three decades. Most economists would agree that there are major lessons to be drown for other countries from East Asian's experiences.

The average growth rate of GDP in the region has been 5% every year during the period (1960-90). It has been recorded as the highest economic growth rate in many years.
There has been a lot of discussion among economists to explain the "East Asian Miracle" in the past and recent years. Alwyn Young (1998), Chang-Tai Hsieh (1997) and Dani Rodrik (1997) are among those who have work in this area.
Theoretic and empirical analysis in this field has been divided in two main economic growth theories: neoclassical economic growth theory and endogenous growth theory.
The neoclassical economists, for instance the World Bank (1991), have been rather critical of interventionist policy which has been implemented by the governments in this region, emphasising instead the various problems attached to interventionism such as misallocation of resource, efficiency loses, rent-seeking behaviour and so on. However, the advent of new growth theory, with its emphasis on endogenous technological progress and externalities, has somewhat challenged the theoretical basis for this standpoint. East Asian Economic growth has been an interesting topic not only because it has had a high economic performance but also because of its deep and useful discussions.
This paper generally contains two main parts: In part one I present both the neoclassical growth theory of so- called Solow- Swan model and summary of different points of views about the rapid economic growth in East Asia. This discussion will be concentrated mainly on two points. First, we will examine which factors have secured such high economic performance in this region. Second, why have some East Asian economies had higher growth rate than others, in other words explaining differences between the economic performance within this region. In part two prior to estimate the coefficients and find convergence rate through data I will present our econometrics model. The best econometric model for economic growth is panel data analysis, particularly panel data dynamic model. One advantage of the panel data is that it includes both time and individual variation.

In empiric part of this paper, I would like to estimate my model by using data both from the East Asia and other part of the world. Then I am going to estimate the coefficients of the model within the region. In first case I try to find convergence rate between East Asian and some advanced economies, and in the second one I would like to show convergence rate within the region. This paper has also an appendix which contains some extra explanations and materials belonging to empirical analysis.

2- the growth model and East Asian economic Performance

In spite of many critiques on neoclassical economic growth model, i.e., the Solow-Swan model, this model has still kept its central role in economic growth and many new research papers in recently years, particularly in empiric study, are based on this model. I have arranged this part as follows:

Section 1, present of the Solow model and its properties, an analysis of the dynamic equation for the capital stocks, transitional dynamics and definition of steady state and convergence. Section 2 discusses technical progress in the model. In section 3 I would like to present a summary of theoretical and empirical objection on neoclassical model. In section 4 we take one step further and see our model with multiple capital goods. Section 5 concentrate on the East Asian economic performance, which includes two main points: its successful economic performance as a region and high economic performance within the region. This section contains both theoretical and empirical analysis which are based on Young(1998) and Rodrik's (1997) researches.

2.1-The Solow –Swan model

(Growth model with exogenous saving rate)

In this model there are only two inputs, physical capital, K(t), and labour, L(t), [We use here simplified form which excludes markets and firms]. The production function takes the form:

$$Y(t) = F[K(t), L(t)] \qquad (2.1.1)$$

Where:

Y(t) = the flow of output produced at time t;

The production function depends on time t, to reflect the effects of technology progress.

Assumptions:

We assume a one- sector production technology which output is a homogeneous good that can be consumed, C (t), or invested, I(t), to create new unite of physical capital, K(t).

We assume here that the economy is closed: household cannot buy foreign goods or assets and can not sell home goods or assets abroad. In a closed economy, output equals income, and the amount invested equals the amount saved. Let s (.) be the fraction of output that is saved (saving rate), so that 1-s (.) = c is the fraction of output that is consumed. For simplicity we further assume s(.) is given exogenously and s(.) = s >0

We assume that capital depreciates at the constant rate δ >0; that is, at each point in time, a constant fraction of capital stock wears out and, hence, can no longer be used for production. the net increase in the stock of physical capital at a point in time equals gross investment less depreciation:

$\dot{K}$ = I - δ K = s F (K, L, t) - δ K (2.1.2)

Where:

$\dot{K}$ = Differentiation with respect to time;

0<s<1

Equation (21.2) determines the dynamics of K for a given technology and labour forces for the moment we neglect technological progress, it means we assume that F (.) is independent of t.

4 – We assume (simplify) that population grows at a constant, exogenous rate, $\frac{\dot{L}}{L} = n \geq 0$ If we normalize the number of people on time 0 to 1 and the work intensity per person also to1, then the population and labour force at time t are equal to

$$L(t) = e^{nt}$$

If we neglect technological progress, the production function from equation (3.1) takes the form:

$$Y = F(K, L) \qquad (2.1.4)$$

The production function is neoclassical if the following three properties are satisfied:

1 – For all K>0 and L > 0, F(.) exhibits positive and diminishing marginal products with respect to each input:

$$\frac{\partial F}{\partial K} > 0, \qquad \frac{\partial^2 F}{\partial K^2} < 0$$

$$\frac{\partial F}{\partial L} > 0, \qquad \frac{\partial^2 F}{\partial L^2} < 0. \qquad (2.1.5a)$$

2- F(.) exhibits constant returns to scale:

$$F(\lambda K, \lambda L) = \lambda \,.\, F(K, L) \text{ for all } \lambda > 0 \qquad (2.1.5b)$$

3 – The marginal product of capital (or labour) approaches infinity as capital (or labour) goes to 0 and approaches 0 as capital (or labour) goes to infinity:

$$\lim_{K \to 0} (F_K) = \lim_{L \to 0} (F_L) = \infty$$

$$\lim_{K \to \infty} (F_K) = \lim_{L \to \infty} (F_L) = 0 \qquad (2.1.5c)$$

These last properties are called Inada conditions, following Inada (1963)

The condition of constant return to scale implies that output can be writing as:

$$Y = F(K, L) = L\,F\left(\frac{K}{L}, 1\right) = L\,f(k)$$

Where:

$k = \frac{K}{L}$ the capital – labour ratio;

$y = \frac{Y}{L}$ is per capita output;

f(k) = F (k, 1)

This result means that the production function can be expressed in intensive form as y = f(k). We can use the condition Y = L.f (k) and differentiate with respect to K, for fixed L, and then with respect to, L, for fixed K, to verify that the marginal products of the factor inputs are given by

$$\frac{\partial Y}{\partial K} = f^{'}(k), \qquad (2.1.6)$$

$$\frac{\partial Y}{\partial L} = [f(k) - k\,f^{'}(k)] \qquad (2\ .1.\ 7)$$

The Inada conditions imply $\lim_{k \to o} [f^{'}(k)] = \infty$ and $\lim_{k \to \infty} [f^{'}(k)] = 0$

We can show that the neoclassical properties, Eqs. (2.1.5a)-(2.1.5c), imply that each input is essential for production, that is, F (0, L) = F (K, 0) = 0, the neoclassical properties also imply that output goes to infinity as either input goes to infinity.

One, simple production function that is often useful of actual economies is the Cobb – Douglas function,

$$Y = A\,K^{\alpha}\,L^{1-\alpha} \qquad (2.1.8)$$

Where:

A > 0 is the level of technology;

α Is constant with $0 < \alpha < 1$

The Cobb- Douglas function can be written in intensive form as:

$$y = A\,k^{\alpha} \qquad (2.1.9)$$

We should note that:

$$f^{'}(k) = A\alpha\ k^{\alpha-1} > 0\ ,\quad f^{''}(k) = -\ A\ \alpha(1-\alpha)\ k^{\alpha-2} < 0$$

$$\mathrm{Lim}_{k\to\infty} f^{'}(k) = 0,\qquad \mathrm{Lim}_{k\to\circ} f^{'}(k) = \infty$$

Thus, the Cobb-Douglas form satisfies the properties of a neoclassical production function.

a-Dynamic Equation for the capital stocks :

The change in the capital stock over time is given by Eq. (2.1.2). If we divide both sides of equation by L, then we get

$$\frac{\dot{K}}{L} = sf(k) - \delta k$$

We can write $\frac{\dot{K}}{L}$, as a function of k by using the condition

$$k = \frac{d(\frac{K}{L})}{dt} = \frac{\dot{K}}{L} - nk$$

Where n = $\frac{\dot{L}}{L}$. If we substitute this result into the expiration for $\frac{\dot{K}}{L}$ then we can rearrange terms to get

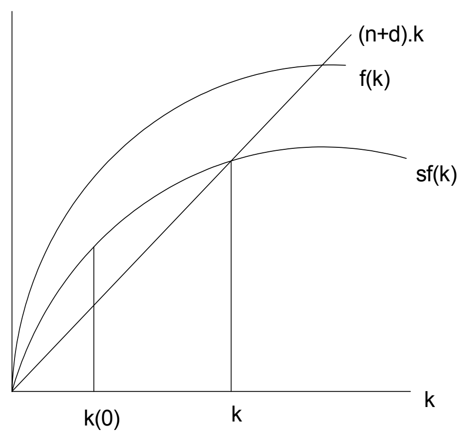
$$\dot{k} = s\,.f(k) - (n + \delta).\,k \qquad (2.1.10)$$

Equation (2.1.10) is the fundamental equation of the Solow –Swan model. This nonlinear equation depends only on k.

The term n + δ can be thought of as the effective depreciation rate for the capital / labour ratio. If the saving rate, s, were 0, then k would decline partly due to depreciation of K at the ratio δ and partly due to growth of L at the rate n.

We can show the working of equation (2.1.10) at the following figure:

Figure (2.1.1)



b-The Steady State

We define a steady state as a situation in which the various quantities grow a constant rate. In the Solow-Swan model, the steady state corresponds to $\dot{k} = 0$ in equation (2.1.10), that is, to intersection of the s. f (k) curve with the (n + δ). K line in figure (2.1.1). The corresponding value of k is denoted k^* . Algebraically, k^* satisfied the condition

$$s .f (k^*) = (n + \delta) . k^* . \qquad (2 .1.11)$$

Since k is constant in the steady state, y and c also constant at the values $y^* = f (k^*)$ and $c^* = (1\text{-}s).f (k^*)$, respectively. Hence, in the neoclassical model, the per capita quantities k, y and c do not grow in the steady state. The constancy of the per capita magnitudes means that the level of variables – K, Y, and C – grows on the steady state at the rate of population growth, n.

Changes in the level of technology, represented by the shifts of the production function, f(.); in the saving rate, s; in the rate of population growth, n; and in the depreciation rate, δ ; all have effects on the per capita levels of various quantities in the steady state.

c-Transitional Dynamics

The long run growth rates in the Solow – Swan model are determined entirely by exogenous elements. Hence, the main substantive conclusions about the long run are negative, for example, the steady state growth rates are independent of the saving rate and the level of production function. The model does, however, have more interesting implications about transitional dynamics. This transition shows how an economy's per capita income converges toward its own steady–state value and to the per capita incomes of other economies.
The growth rate of k is given by

$$\gamma_k = \frac{\dot{k}}{k} = \frac{s.f(k)}{k} - (n + \delta). \qquad (2.1.12)$$

Where γ_k denotes a growth rate of capital. We must remember that the growth rate of the level of variable equals the per capita growth rate plus n, for example,

$$\gamma_K = \gamma_k + n.$$

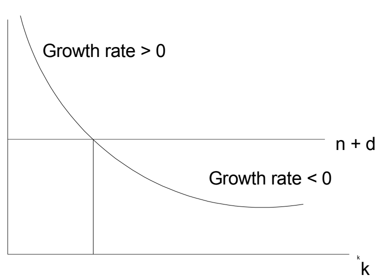


figure (2.1.2)

Figure (2.1.2) shows that to the left of the steady state, the s. f (k)/k curve lies above n + δ . Hence, the growth rate of k is positive, and k rises over time. As k increases, γ_k declines and approaches 0 as k approach k^*. The economy tends asymptotically toward the steady state in which k –and, hence, y and c – do not change.
The source of these results is the diminishing returns to capital: when k is relatively low, the average product of capital, f (k) / k, is relatively high. By assumption, households save and invest a constant fraction, s, of this

product. Hence, k is relatively low, the gross investment per unite of capital, k, effectively depreciates at the constant rate n + δ . Consequently, the growth rate, $\frac{\dot{k}}{k}$, is also relatively high.

An analogous argument demonstrates that if the economy starts with k (0) > k^*, then the growth rate of k is negative, and falls over time. the growth rate increase and approach 0 as k approach k^* . Thus, the system is globally stable: for any initial value, k (0) > 0, the economy converges to its unique steady state, k^* > 0.
We can also study the behaviour of output along the transition path. The growth rate of output per capita is given by

$$\gamma_y = \frac{\dot{y}}{y} = f'(k) . \dot{k} / f(k) = [k . f'(k)/ f(k)] . \gamma_k \qquad (2.1.13)$$

The expression of [k. f' (k) / f (k)] is often called the capital share, that is, the capital share of the rental income on capital in total income. Equation (2.1.13) shows that the relation between γ_y and γ_k depends on the behaviour of the capital share.
Generally, we can substitute for γ_k from Eq. (2.1.12) into Eq. (2.1.13) to get

$$\gamma_y = s . f'(k) - (n + \delta) . Sh (k),$$

$$\frac{\partial \gamma_y}{\partial k_k} = [\frac{f''(k).k}{f(k)}] . \gamma_k - \frac{(n+\delta)f'(k)}{f(k)} . [1 - Sh (k)].$$

If $\gamma_k \geq 0 \Rightarrow \frac{\partial \gamma_y}{\partial \gamma_k}$<0, thus γ_y falls as k rises.

If γ_k < 0 (k > k^*) $\Rightarrow$, then the sign of $\frac{\partial \gamma_y}{\partial \gamma_k}$ is ambiguous, if the economy is close to steady state then $\frac{\partial \gamma_y}{\partial \gamma_k} < 0$.

In this model, since c =(1- s) .y, and $\gamma_c = \gamma_y$, then consumption exhibits the same dynamics as output.

d –Absolute convergence

Convergence is a key prediction of neoclassical growth model which simply conclude that the initially poorer economies with lower value of initial capital k(0) and initial output y(0), trends to catch-up to the initially richer ones. The differences in capital stocks and output are gradually eliminate as each economy approaches the common steady state value.

For development of a single country over time, the model predicts that growth rates will be high when capital per workers is low and will decline as capital per workers rises.

In the extended models that allow for population growth and technological progress, the convergence hypothesis depends on each country having the same steady state path $(\frac{Y}{L})^*$ the poorer grow faster per capita than rich if poor and rich are approaching the same (moving) target. The target is the same, however, only if the economies are basically similar.

In addition to a common production function and equal value of δ (depreciation rate) and s (saving rate), the country must have the same rates of population growth and technological progress.

The hypothesis that poor economies tend to grow faster per capita than rich ones –without conditioning on any other characteristics of economies – is referred to as absolute convergence.

This hypothesis receives only modest support when confronted with data on group of economies. Empirical studies with data from a large numbers of countries show that the hypothesis does not fit the data. Hence, absolute convergence does not apply for a broad cross section of countries. The hypothesis fares better if we examine a more homogenous group of economies. Robert Barro (1995) by empirical study shows that the absolute convergence hypothesis can be satisfied to the data from 20 relatively advanced countries that are member of OECD (organisation for economic cooperation and development). In this case, the initially poorer countries did experience significantly higher per capita growth rates.

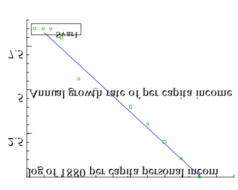


Figure (2.1.3)

We can modify the theory to the empirical evidence on convergence, and drop the assumption that all economies have the same parameters, and the same steady state. If the Steady states are not the same, then we must modify our analysis to consider a new concept, namely conditional convergence. The key idea is that an economy grows faster the further it is from its own steady- state value. The main point is that per capita growth is higher the Higher the gape between $(\frac{Y}{L})^* = y^*$ and $(\frac{Y}{L}) =$ y. Consider two countries M and N. Such that y_M is twice as large as y_N, the poor country, N grow faster than M if it has the same steady-State path as M. But if y^*_M is twice as large as y^*_N, then the two countries grow at the same rate. The point is that the theory implies a form of relative convergence. The growth rate does not depend on the absolute value of y, but rather on the value measured relative to the Economy's own steady – state position. If a country has low per-worker product along the steady-state path, then the theory does not predict that this country will grow rapidly.

As we mentioned above that convergence means economies with lower levels of per capita Income (expressed relative to their steady-state levels of per capita income) tend to grow faster in per capita terms. But this concept is often confused with an alternative meaning of convergence that the dispersion of real per capita income across a group of economies tends to fall over time. The last convergence is called σ convergence.

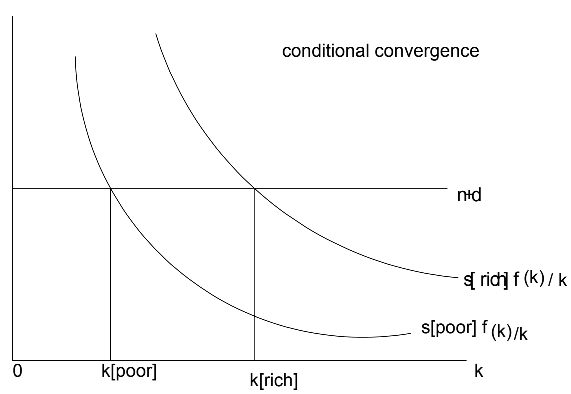


figure (2.1.4)

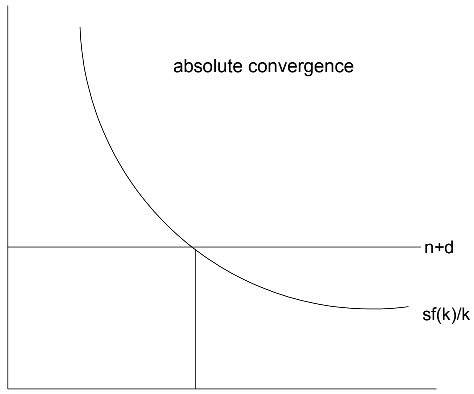


figure (2.1.5)

We should remember that beta convergence, consider the speed with which the logarithm of per capital output, or output for short, tends to its steady-state value from some initial condition. The estimate of the speed of convergence is based on either the coefficient of the lagged dependent variable in time series or panel regression or the coefficient of the logarithm of initial output in cross section regression.

As drown in figure (2.1.6) economies 1 and 2 converge toward each other, as do economies 3 and 4.

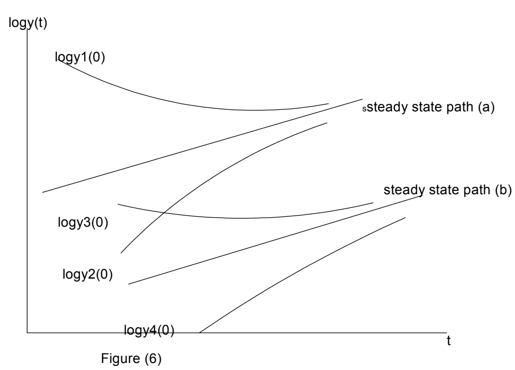


Figure (2.1.6)

The second notation, sigma convergence, focuses on the behaviour of the cross country variance of output over time. As has been noted by Friedman (1992) and Quah (1993), beta convergence is only a necessary and not a sufficient condition for output dispersion to reduce. Sigma convergence is theoretically interesting if one believes that there is a common equilibrium across countries, determined by share global technologies and testes, and that the speed of convergence to steady state outputs is the same across countries.

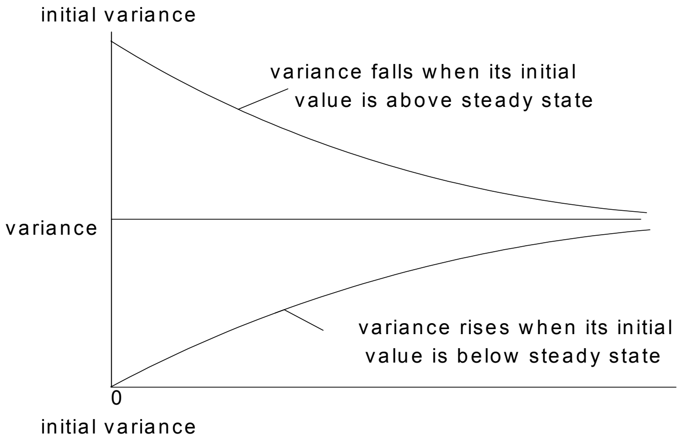


figure (2.1.7)

(Figure 2.1.7 displays σ convergence)

2.2-Technoligical progress

The assumption that the level of technology is constant over time is clearly unrealistic. The extension of the analysis above to include technical progress is simple, at least when we consider only the simpler case in which the technology improves exogenously. The first issue is how to introduce exogenous technological progress into the model. This progress takes various forms

(1) Hicks says that a technological innovation is neutral (Hicks neutral) if the ratio of marginal products remain unchanged for a given capital / labour ratio. This property corresponds to a renumbering of the isoquants, so that Hicks – neutral production functions can be written as

$$Y = F(K, L, t) = T(t) F(K, L) \qquad (2.2.1)$$

Where T (t) is an index of the state of technology, and $\dot{T}(t) \geq 0$

(2) Harrod defines an innovation as neutral (Harrod neutral) if the relative input shares $K.F_K / L.F_L$ remain unchanged for a given capital/output ratio. This definition takes the following form:

$$Y = F[K, A(t)L] \qquad (2.2.2)$$

Where A (t) is an index of the technology, and $\dot{A}(t) \geq 0$. This form is called labour – augmenting technological progress because it raises output in the same way as an increase in the stock of labour.

(3) Solow defines an innovation as neutral (Solow neutral) if the relative input shares LF_L / KF_K, remain unchanged for a given labour/output ratio. This definition can be shown to imply a production function of the form

$$Y = F\,[K\,B\,(t), L) \qquad (2.2.3)$$

Where B(t) is an index of the technology, and $\dot{B}(t) \geq 0$. Production function of this form is called capital augmenting because a technological improvement increases production in the same way as an increase in the stock of capital.

a- The Solow - Swan model with labour – augmenting technological progress

Let the production function includes labour – augmenting technological progress.

$$Y = F\,[K, L\,A\,(t)]$$

And the technological term, A (t), grows at the constant rate x. The condition for the change in the capital stock is

$$\dot{K} = s\,F\,[K, L\,A(t)] - \delta K$$

$$\Rightarrow$$

$$\dot{k} = s\,F[k, A\,(t)] - (n + \delta)k \qquad (2.2.4)$$

The capital growth rate can be calculated

$$\gamma_K = s\;\; f\,[k, A\,(t)] / k - (n + \delta) \qquad (2.2.5)$$

The growth rate of k in the steady state:

By assumption γ_K^* is constant. Since s, n, and δ are also constants, Eq. (2.2.5) implies that

F [k, A(t)]/ k = F[1, A (t) / k]

F [1, A (t) / k] is constant only if k and A (t) grows at the same rate, that is $\overset{*}{\gamma}_K = x$.

We can summarize the following changes in the model:

Output per capita is given

Y = F [k, A(t)] = k . F[1,A (t) / k]

The quantity of output per unit of effective labour is given by

$\hat{y}$ = F ($\hat{k}$, 1) = f ($\hat{k}$) (2.2.6)

Where:

$\hat{y}$ = Y / [L A (t)]

$\hat{k}$ = K / A (t) = K /[L. A (t)]

$\hat{L}$ = L A (t) is often called the effective amount of labour.

Dynamic equation for $\hat{k}$

$$\gamma_{\hat{K}} = s\, f(\hat{k}) / \hat{k} - (x + n + \delta) \qquad (2.2.7)$$

Since the steady -state growth rate of $\hat{k}$ is zero, the steady state value $\hat{k}^*$ satisfied the condition

$$sf(\hat{k}^*) = (x + n + \delta)\hat{k}^* \qquad (2.2.8)$$

The transitional dynamic of $\hat{k}$ are qualitatively similar to those of k in the previous model. In the steady state, $\hat{k}, \hat{y}$ and $\hat{c}$ are constant.

It is important to know the speed of the transitional dynamics. If convergence is rapid, then we can focus on steady state behaviour. Conversely, if convergence is slow, then economies would typically be far from their steady state, and, hence, their growth experiences would be dominated by the transitional dynamics.

A quantitative assessment of the convergence speed for the case of the Cobb-Douglass production function can be obtained as follow:

First we determine the growth rate of $\hat{k}$ in the Cobb-Douglass case as

$$\gamma_{\hat{k}} = sA(\hat{k})^{-(1-\alpha)} - (x + n + \delta) \qquad (2.2.9)$$

We shall find it useful to consider a log-linear approximation of (2.2.9) in the neighbourhood of the steady state:

$$\gamma_{\hat{k}} = d\left[\log(\hat{k})\right]/dt \cong -\beta\left[\log(\hat{k}/\hat{k}^{*})\right],$$

$$\beta = -(1-\alpha)(x+n+\delta). \qquad (2.2.10)$$

The coefficient β determines the speed of convergence from $\hat{k}$ to $\hat{k}^{*}$.

2.3- Theoretical and Empirical Objections

After we have presented the neoclassical model, it is the time to ask us the following question:

Is the neoclassical model a good theory of economic growth? Although this question is largely empirical, one might also answer it along theoretical lines.

Here, we consider some possible theoretical objections one might lodge against the neoclassical growth model. Some theoretical objections are as follows:

a) According the neoclassical growth model, in the steady state, all growth is due to advances in technology, but technological progress is taken as exogenous. It might seem that the model solves the mystery of economic growth simply by assuming that there is economic growth. Indeed, this critique opened way for endogenous growth theory.

If the goal is to explain why standard of living are higher to day than a century ago, then the neoclassical can not explain it so well. The goal is not to explain the existence of economic growth. It is obvious that living standards rise over time largely because knowledge expands and production function improves. A more important is to explain the variation of economic growth that we observe in different countries and different times.

b) To use the neoclassical model to explain international variation in growth requires the assumption that different countries use roughly the same production function at a given point in time. To say that different countries have the same production is merely to say that if they had the same inputs, they would produce the same outputs. Different countries with different level of inputs need not rely on exactly the same process for producing goods and services.

When an economy doubles its capital stock, it does not give each worker twice as many shovels. Instead, it replaces shovels with bulldozers. For the purposes of modelling economic growth, this change should be viewed as a movement along the same production function, rather than as a shift to a completely new production function

In summery, various theoretical objections can be advanced against the neoclassical growth model. Yet non-is compelling. More important is the empirical question:

Can the model help to explain the wide variation in economic experience observed throughout the world?

Mankiw (1995) emphasis on three problems for neoclassical growth theory. Here I will present them briefly.

a-The magnitude of international differences

Let us assume that all economies were in their steady – states. The model predicts that different countries should have different levels of income per person, depending on the various parameters that determine the steady state. To see these predictions, consider the two steady – state condition:

$sy^* = (n + x + \delta)\, k^*$ [saving must equal breaking – even investment]

(2.3.1)

$y^* = f(k^*)$ [production function]

(2.3.2)

To see the predicted variation in income per person, differentiate this system and solve for dy^*

$$dy^* / y^* = [\alpha/(1-\alpha)]\, [ds / s - d(n + x + \delta)/(n + x + \delta)] \qquad (2.3.3)$$

Where $\alpha = f'(k^*)k^* / f(k^*)$. If the factors of production earn their marginal product, then α is the steady – state capital share. A standard estimate of the capital share is 1/3, so $\alpha(1-\alpha) = 1/2$

The equation says that differences in rates of saving will lead to difference in income that are proportionately half as large. If one country's saving rate is four times that of another country, its steady – state income will be about twice as large. The equation also has numerical implications for the impact of population growth.

Calculations show that the neoclassical model does not predict the large differences in income observed in the real world. There is much more disparity in international living standards than the neoclassical model predicts.

These results might once again call into question the assumption that all countries operate with the same production function. Perhaps poor countries have not only low saving and high population growth, but also poor production technologies. But it should be clear that the magnitude of the unexplained differences makes this explanation unsatisfactory. Mankiw's calculation shows that the neoclassical model leaves a multiple of five in income per person unexplained.

b-The rate of convergence

As we saw early in this paper, convergence hypothesis is plausible for simples that include relatively homogenous economies like the countries of OECD or the states of the US. But more diverse samples give the opposite result.

Generally, the neoclassical model predicts that each economy converges to its own steady – state, which in turn is determined by its saving and population growth rates. As we remember this prediction has been called conditional convergence. Most empirical studies have found evidence of conditional convergence a rate of about 2 % per year. That is, each country moves 2 percent closer to its own steady state in thirty-five years.

Although conditional convergence is qualitatively consistent with the neoclassical model, the model begins to have problem once again when we turn to its quantitative predictions. According to the model, income converges to its steady state level as follows:

$$\dot{y} = \lambda \; (y - y^{*}) \qquad (2.3.4)$$

Where:

$$\lambda = (1-\alpha)\,(n + x + \delta) \qquad (2.3.5)$$

(We will see how to drive this equation later)
The key parameter here is the rate of convergence, λ. This parameter measures how quickly a deviation from steady state dissipates over time. This formula easily calibrated. In the United States, for example, the capital shares, α, is about 1/3, and the rate of population growth, n, is one percent per year. The average rate of growth of income per person is about 2% per year, which gives us a value for x. We can also estimate the depreciation rate, δ, of 3% per year. Together with the equation above, these estimates give a predicted rate of convergence, λ, of 4% per year.

At this rate, an economy would go half way toward its steady state in seventeen and one – half years.

Empirical studies show that the model predicts convergence at about twice the rate that actually occurs. In practice, economies do regress toward their conditional mean, but only slowly. The initial condition of an economy matters for much longer than the model says it should.

c – Rates of return

The predicted difference in rate of return by neoclassical model is another problem. If poor countries are because they have small capital stocks, then the marginal product of capital should be high. We should, therefore, observe higher profit rates and higher real interest rates in poor countries. Moreover, capital should be eager to flow from rich to poor countries.

There is some evidence for return differentials of this sort. It is not difficult to find that capital – income ratios are more than twice as large in rich as in poor countries. Unless rich countries have capital shares that are also more than twice, they must have lower profit rates. This seems qualitatively consistent with neoclassical model. The neoclassical model runes into trouble when we turn from qualitative to quantitative predictions about rate of return. Consider the following equations:

$$Y = f(k) \text{ [production function]} \qquad (2.3.6)$$

$$R = f'(k) \text{ [gross return of capital} \qquad (2.3.7)$$

Further

$$dR / R = [f f'' / (f')^2] \; dy / y \qquad (2.3.8)$$

$$\Updownarrow$$

$$dR / R = -[(1\text{-}\alpha) / (\alpha\sigma)] \; dy / y \qquad (2.3.9)$$

Where

α = *capital* Share

σ = The elasticity of substitution between capital and labour.

As we see, it is impossible to make a quantitative prediction about return differentials without saying something about the elasticity of substitution between capital and labour. If production function is Cobb – Douglass, then σ = 1 standard return of α is 1/3, so

$$(1\text{-}\alpha) / (\alpha\sigma) = 2$$

That is, return to capital moves proportionately twice as much (in the opposite direction) as the level of income. Because poor countries have about one – tenth the income of rich countries, they should have returns to capital that are about one hundred times as large. In particular, since the profit rate is about 10 % per year in rich countries, it should be about 1000 percent per year in poor countries. The return differential is so large that the failure of capital to move toward poor countries can not be explained by invoking information costs or political risk.

Although the size of the predicted return differentials can be reduced by assuming a large σ, the return differential seems still too large to be explained by political risk …etc. In other words the return differentials predicted by the neoclassical model are vastly larger than are observed in the real world.

2.4-The neoclassical model: Multiple capital goods

A well-known model due to Mankiw, Romer and Weil (1992) adds human capital to Solow-Swan model, and develops empirics that potentially better explain the cross-country income data than models that account only for physical capital accumulation following Solow's original work.

Here K have two components: physical capital K_p and human capital K_h

$$K = (K_p, K_h)'$$

Then

$$\dot{K}_p = s_p Y - \delta_p K_p \qquad s_p, \delta_p > 0$$

$$\dot{K}_h = s_h Y - \delta_h K_h \qquad s_h, \delta_h > 0$$

$$s_h + s_p < 1$$

Then technology-intensive effective capital stocks $\hat{k} = (\hat{k}_p, \hat{k}_h)'$ with $\hat{k}_p = K_p / \hat{N}A$ (*)[1]

and

$\hat{k}_h = K_h / \hat{N}A$ Satisfy

$$\dot{\hat{k}}_p / \hat{k}_p = s_p \hat{y} / \hat{k}_p - (\delta_p + n + x)$$

$$\dot{\hat{k}}_h / \hat{k}_h = s_n \hat{y} / \hat{k}_h - (\delta_h + n + x)$$

Balanced-growth equilibrium is a positive time-invariant triple $(\hat{y}, \hat{k}_p, \hat{k}_h)^*$ such that

$$\hat{y} = f(\hat{k}_p, \hat{k}_h)$$

$$s_p \hat{y} / \hat{k}_p = \delta_p + n + x$$

$$s_h \hat{y} / \hat{k}_h = \delta_h + n + x$$

When F is Cobb-Douglass so that

$$\text{f}(\hat{k}_p, \hat{k}_h) = (\hat{k}_p)^{\alpha_p} (\hat{k}_h)^{\alpha_h} \qquad \alpha_p, \alpha_h > 0, \alpha_p + \alpha_h < 1 \qquad (2.4.1)$$

Calculation shows that a balanced –growth equilibrium has:

$$\begin{pmatrix} \log \hat{k}_p^* \\ \log \hat{k}_h^* \end{pmatrix} =$$

$$(1-\alpha_p-\alpha_h)^{-1} \begin{bmatrix} -(1-\alpha_h) & -\alpha_h \\ -\alpha_p & -(1-\alpha_p) \end{bmatrix} \times \begin{bmatrix} \log((\delta_p + n + x)s_p^{-1} \\ \log((\delta_h + n + x)s_h^{-1} \end{bmatrix} = (1-\alpha_p-\alpha_h)^{-1} \times$$

$$\begin{pmatrix} (1-\alpha_h \log((\delta_p + n + x)^{-1} s_p + \alpha_h \log((\delta_h + n + x)^{-1} s_h) \\ \alpha_p \log((\delta_p + n + x)^{-1} s_p) + (1-\alpha_p) \log((\delta_h + n + x)^{-1} s_h \end{pmatrix}$$

And

$$\text{Log } \hat{y}^* = (1-\alpha_p-\alpha_h)^{-1} \left[\alpha_p \log((\delta_p + n + x)^{-1} s_p) + \alpha_h \log((\delta_h + n + x)^{-1} s_h) \right]$$

(2.4.1)’

(*) Human capital H multiplies the labour input N to produce effective labour input $\widetilde{N}$

Equation (2.4.1)' is the MRW counterpart to the Solow-Swan levels prediction (2.4.1).

It specializes to the latter when $\alpha_p = 0$, it comprises a geometric average of contributions from physical and human capital.

Mankiw, Romer and Weil achieve this by setting equal the depreciation rates of human and physical capital, i.e., $\delta_p = \delta_h$.

From (2.4.1), and taking the first –order Taylor series expansion in log $\hat{y}, \log \hat{k}_p$ and log $\hat{k}_h$, we have:

$$\dot{\hat{y}} / \hat{y} = \alpha_p \dot{\hat{k}}_p / \hat{k}_p + \alpha_h \dot{\hat{k}}_h / \hat{k}_h = \alpha_p \left[s_p \hat{y} / \hat{k}_p - (\delta_p + n + x) \right] +$$

$$\alpha_h \left[s_h \hat{y} / \hat{k}_h - (\delta_h + n + x) \right] \overset{a}{=} \alpha_p \left[(\delta_p + n + x)((\log \hat{y} - \log y^*) - (\log \hat{k}_p - \log \hat{k}_p^*)) \right] +$$

$$\alpha_h \left[(\delta_h + n + x)((\log \hat{y} - \log y^*) - (\log \hat{k}_h - \log \hat{k}_h^*)) \right] \qquad (2.4.2)$$

So that $\delta_p = \delta_h = \delta$ then gives

$$\dot{\hat{y}} / \hat{y} = -(1 - \alpha_p - \alpha_h)(\delta + n + x) \times (\log \hat{y} - \log \hat{y}^*) \qquad (2.4.3)$$

$$\beta \overset{def}{=} -(1 - \alpha_p - \alpha_h)(\delta + n + x) < 0 \qquad (2.4.4)$$

So that

$$\log \hat{y}(t) - \log \hat{y}^* = \left[\log \hat{y}(0) - \log \hat{y}^* \right] e^{\beta t}$$

$$\Rightarrow$$

$$\log \hat{y}(t+T) - \log \hat{y}^* = \left[\log \hat{y}(t) - \log \hat{y}^* \right] e^{\beta T}.$$

Transforming to get observable logy (t). This becomes:

$\log y(t+T) - \left[\log A(0) + (t+T)x \right] = (1 - e^{\beta T}) \log \hat{y}^* + \left[\log y(t) - \log A(0) - tx \right] e^{\beta T}$. Hence,

$$\log y(t+T) - \log y(t) = (1 - e^{\beta T}) \log \hat{y}^* + (e^{\beta T} - 1) \log y(t) + (1 - e^{\beta T}) \log A(0) + (t + T - e^{\beta T} t)x$$

Substituting in (2.4.1)' for steady state log $\hat{y}^*$ gives;

Log y(t+T)-log y(t) =(1-

$$e^{\beta T}) \log A(0) + (t + T - e^{\beta T})x + (e^{\beta T} - 1) \log y(t) + (1 - e^{\beta T}) \frac{\alpha_p}{1 - \alpha_p - \alpha_h} \log$$

$$s_p + (1 - e^{\beta T}) \frac{\alpha_h}{1 - \alpha_p - \alpha_h} \log s_h - (1 - e^{\beta T}) \frac{\alpha_p + \alpha_h}{1 - \alpha_p - \alpha_h} \log(\delta + n + x)$$

(2.4.5)

In words, growth depends on some (exogenously given) constants, technological change, and population growth rate.

Since $\beta < 0$, the coefficient on the initial level logy (t) should be negative.

Comparing MRW's convergence rate (2.4.4) with Solow-Swan's (2.2.10), the only difference is the addition of α_h in the former. Thus, keeping fixed α_p, δ, n and x, MRWs addition of human capital to the neoclassical model implies β closer to zero, or a slower rate of convergence, than in the Solow-Swan model. (Steven N. D. and Danny T. Q., 1998)

2.5-East Asian Economic Performance

In spite of the East Asian economic slowdown and financial crises in recently years, the region has had one of the most successful economic growth in the past decades. From 1960 - 1990 the average GDP per capita increased by more than 5% annually in countries like Hong Kong, Indonesia, Japan, Malaysia, Singapore, South Korea, Taiwan and Thailand. Their output in manufacturing increased even more rapidly and their share of the World trade in manufactures was more than doubled. For example per capita income in South Korea in 1960 was almost the same as Bangladesh but today its per capita income is almost the same as some poorest countries in Europe. The economic performance among East Asian countries has not been the same, for instance, South Korea differs more from Hong Kong it does from, say, Brazil or Turkey. The Philippines' economics performance during the 1980s makes it more of a Latin American country then an East Asian one. Both rapid and a long period of growth in this region have made broad discussion and different explanation among economists. All these economists have tried to explain why East Asia has done so much better than other regions of the world.

This section first presents the summary of such discussion and different explanation, then we pay attention why some East Asian countries like South Korea and Singapore have been more successful than others. As I mentioned high Performance Asian Economy (HPAE) has been a controversial subject among economists, even some economists believe the high performance Asian economy is neither efficient nor permanent. To give an answer we start our discussion by this question:

2.5 a-Which factors have secured such high economic performance?

As we know there are two main sources for economic growth namely, increase in input (growth in employment, in the education level of workers, and the stock of physical capital) and increase in the output per unit of input which secure economic growth. Increase of efficiency may result from better management or better economic policy, but in the long run are primarily due to increase in knowledge. The basic idea of growth accounting is to give life to this formula by calculating explicit measure of both. The accounting can then tell us how much of growth is due to each input-say, capital as opposed to labour – and how much is due to increased efficiency.

Economists examining this controversial subject have generally been divided in two groups: First group, which underlies neoclassical model for explanation, believes input growth has secured high economic performance in this region. The second group argues that both capital accumulation and total productivity have played important roll in this case.

Krugman (1994) claims there is no mysterious at all in HPAE and he compares the East Asian economic growth with Soviet Union economic performance in 1950s. He further says the future prospects for that growth are more limited than almost anyone now imagines. Sustained growth in a nation's per capita income can only occur if there is a rise in output per unit of input. Mere increases in inputs, without increase in the efficiency with which those inputs are used must run into diminishing returns, input-driven growth is inevitably limited.

Krugman goes further and compares the economic growth in East Asian countries with economic growth in Soviet Union in 1950s. He believes the East Asia countries, like the Soviet Union of the 1950s, have achieved rapid growth in large part through an astonishing mobilization of resources. According to Krugman, once one accounts for the role of rapidly growing inputs in these countries' growth, one fined little to explain. He chooses Singapore's economic growth as example. Between 1966 and 1990, the Singapore economy grew remarkable 8.5 percent per annum, three times as fast as the United States; per capita income grew at a 6.6 percent rate, roughly doubling every decade. But such miracle took place because of the mobilization of resources. The employed share of population surged from 27 to 51 percent. The educational standard of that work force were dramatically upgraded: while in 1966 more than half the workers had no formal education at all, by 1990 two-thirds had completed secondary education. Above all, the country had made an awesome investment in physical capital: investment as share of output rose from 11 to more than 40 percent. It is clear that Singapore's growth has been based largely on one-time changes in behaviour that cannot be repeated. So one immediately conclude that Singapore is unlikely to achieve future growth rates comparable to those of the past.

According to Krugman empiric studies by Kim and Lau on four Asian "tigers" show that the hypothesis that there has been no technical progress during the post-war period cannot be rejected.

P. Krugman argues that Japan's economic growth is different form other East Asian countries and these economies cannot follow the same path. He adds: "Japan is a country that started out poor and has now become the second-largest industrial power. Why doubt that other Asian nations can do the same?" According to Krugman there are two answers to this question. First there is no a single "Asian system" for Asian success stories, the statistical evidence tells something else. Japan's growth in the 1950s and 1960s does not resemble Singapore's growth in the 1970s and 1980s. Japan, unlike the East Asian " tigers", seems to have grown both through high rates of input growth and through high rates of efficiency growth. Today fast growth economies are nowhere near convergence on U.S. efficiency level, but Japan is staging an unmistakable technological catch-up. Second the era of miraculous Japanese growth now lies well in the past. Most years Japan still manages to grow faster than the other advanced nations, but that gape in growth rates is now far smaller than it used to be, and is shrinking.

As I mentioned above, Krugman is one of those economists who underlie the neoclassical growth theory to analysis the East Asian's economic performance. But he is not alone, Alwyn Young (1998) and many other economists and particularly World Bank, argue the same. Young in his new research under sub-tittles "Labour, not Capital" take one step further and try to show which factor of input has secured economic growth in East Asian economies. He writes: "As I emphasized in Young 1995, Young 1994, and even as early as Young 1992 (p.62), the growth of labour input plays an equal, if not much more important, role"

According to Young if we consider the growth of non-agricultural GDP per worker hour instead of the growth of GDP per capita we can see that there will be a significant reduction of the growth of GDP per capita (see table 2.5a.1). There will be 1.6% reduction of the growth of output per capita in Hong Kong, almost 3% off of the growth of output per capita in South Korea and Taiwan, and a full 3.8% off of the growth of output per capita in Singapore. Young writes: “If one knew the share of the labour in these economies, a “naïve” estimate of productivity growth, i.e. one assuming no deepening of factors, might be that share times the growth of output per capita. This prior would imply sustained total factor productivity growth ranging from a low of 3.5% per annum in Singapore to a high of 5.0% in Taiwan” If one compare these number with Young’s estimates in 1995, one can see that “labour deepening, i.e. the rise in participation rate, transfer of labour out of agriculture, and increase in the human capital of the workforce, accounts for at least two-third of the difference in all of the economies except Singapore, where it still accounts for 59% of Young’s results.

Table (2.5a.1): Sources of East Asian Productivity Growth (1966-1990)

Growth of :	Hong Kong	Singapore	South Korea	Taiwan
GDP/ Population	5.7	6.8	6.8	6.7
Non-ag. GDP/Effec. worker	4.1	3.0	3.9	4.0
Non-ag. GDP/Effec. capital	-0.7	-2.8	-3.4	-3.4
Labour share (avg.)	0.628	0.509	0.703	0.743
Naïve estimate of TFP	3.6	3.5	4.8	5.0
growth Young (1995)	2.3	0.2	1.7	2.1
Of difference:				
Contribution of labour deep.	79%	59%	66%	70%
Contribution of capital deep	21%	41%	34%	30%
Source: Young 1995. Hong Kong refers to 1966-1991				

The long run averages in Table (2.5a.1) obscure important time trends, particularly in the case of

Table (2.5a.2): Total factor Productivity Growth: Singapore

	Annual Growth of:						
Time period	Output	Raw capital	Weighted capital	Raw labour	Weighted labour	TFP	Labour share

period		capital	ed capital	labour	ed labour		share (avg.)
Young (1995)							
66-70	13.0	11.9	13.4	5.4	3.3	4.6	0.503
70-80	8.8	12.2	14.0	5.0	5.8	-0.9	0.517
80-90	6.9	9.1	8.4	3.6	6.6	-0.5	0.506
66-90	8.7	10.8	11.5	4.5	5.7	0.2	0.509
Updated (preliminary)							
66-70	13.1	12.5	13.3	5.4	3.3	4.8	0.503
70-80	8.5	12.3	14.0	5.0	5.8	-1.2	0.517
80-90	7.1	8.9	7.9	3.6	6.6	-0.2	0.515
90-95	8.3	7.2	7.9	2.0	7.9	0.4	0.499
66-95	8.6	10.3	10.7	4.1	6.1	0.3	0.508

Singapore. Table (2.5a.2) shows Young's period by period for Singapore's economy.

As we can see, while output per weighted worker (i.e. adjusted for sex, age, education and hours of work) grew 9.7% per annum between 1966 and 1970, this growth had slowed to 3.0% per annum by the 1970s, and a mere 0.3% per annum during the 1980s. While the growth of the capital stock has slowed, the growth of human capital has accelerated over time. Weighted labour input grew 2.1% slower than raw labour in the late 1960s, but 0.8% faster in the 1970s and 3.0% faster in the 1980s.

Table (2.5a.3): Singaporean Growth rates (Assuming no capital deepening)			
	Output	Labour	TFP
66-70	0.131	0.033	0.049
70-80	0.085	0.058	0.014
80-90	0.071	0.066	0.002
90-95	0.083	0.079	0.002
66-95	0.086	0.061	0.013

We can see in table (2.5a.3), Singapore's productivity growth rate falls monotonically, from an extraordinary 4.9%in the late 1960s, to the moderate 1.4% in the 1970s, and an almost imperceptible 0.2% in the 1980s and early 1990s, as the growth of the output per effective worker has become negligible. Young in his recent research goes deep and in very detail particularly in Singapore's economic growth but his main conclusion is the same we saw above.

Non-neoclassical perspective

As I mentioned earlier, some economists disagree with Young and World Bank and they argue East Asian economic performance shows both input-driving growth and productivity growth.

A.Cappelen and J. Fragerberg are among those economists who oppose World bank and Young's works in East Asian growth performance. An article " East Asian Growth: A Critical Assessment "they have opposed particularly the World Bank conclusions in this case. The World Bank's conclusion was based on a recent across country regression. The Bank has claimed that" between 60 and 90 percent of East Asian output growth drives from accumulation of physical and human capital"(world Bank, 1993:58) and that other factors therefore are of less important. These authors conclude after considering the World Bank's empirical tables (East Asian Growth, page 181-182): such regression model can be made consistent with different theories and often fail to distinguish between them. The second report (world Bank's report) explicitly takes the traditional neoclassical growth model as its point of departure. The purpose of al this appears to be support the view that the loin's share of East Asian growth can be explained by conventional sources, i.e., that there is no miracle to explain. But the analysis is unconvincing. First, what should be shown – that the world confirms to the traditional neoclassical assumptions-is simply taken for granted. Thus, interaction between technological progress and factor accumulation (i.e., externalities) is ruled out by assumption. It is possible that a model based on a competing perspective would have performed better or equally well on the same data. For instance, using a more flexible model Kwon (1994) arrives radically different results from those published by World Bank. Second, the handling of technology lacks internal consistency. On the one hand it is assumed that all countries benefits to the same extent from technological progressive, the traditional public good assumptions, on the other that large differences in technological level of development continue to exist. However, if technology is a global public good, and technology progress is independent of factor accumulation, technological catch-up should be fast and easy. It is also disappointing to note that the result from decades research indicating that technology is not at all a global public good, are completely ignored: Indeed, much of the literature in this area now depicts technology knowledge as a rather local affairs, organizationally and culturally embedded. Third, for most countries “technology efficiency“ as calculated in this study, is continually decreasing, i.e., they become gradually less and less suitable.

“Capital accumulation is the chief proximate cause of East Asian growth”. This assertion is claimed by Dani Rodrik (1997) in his working paper “TFPG Controversies, Institutions, and Economic Performance in East Asia“ In this paper under sub-title “Sources of growth in East Asia : accumulation versus productivity“ he begin his discussion by reviewing a set of estimates of factor productivity by Barry Bosworth and Susan Collins (1996) The estimates of Barry Bosworth and Susan Collins is shown in table (2.5a.4). In this table one can see the different productivity performance among East Asian countries.

Table (2.5a.4): Sources of growth in East Asia and other region, 1960-1994
(Annual percentage rate)

Country/ Region	Output per Worker	Contribution of :		
		Physical capital	education	Factor productivity
Indonesia	3.4	2.1	0.5	0.8
Korea	5.7	3.3	0.8	1.5
Malaysia	3.8	2.3	0.5	0.9
Philippines	1.2	1.2	0.5	-0.4
Singapore	5.4	3.4	0.4	1.5
Thailand	5.0	2.7	0.4	1.8
Taiwan	5.8	3.1	0.6	2.0
East Asia	4.2	2.5	0.6	1.1
South Asia	2.3	1.1	0.3	0.8
Africa	0.3	0.8	0.2	-0.6
Middle East	1.6	1.5	0.5	-0.3
Latin America	1.5	0.9	0.4	0.2
U.S.	1.1	0.4	0.4	0.4
Other industrial countries	2.9	1.5	0.4	1.1

Source: Bosworth and Collins (1996)

According to Rodrik these results on TFPG are controversial and he continues his discussion by this question: “What do the TFPG calculations really show?” Before he answers this question in detail he claims, “the evidence we have on the relative significance of accumulation versus productivity growth is actually much less clear cut than is commonly believed. The evidence on investment rates is direct and speaks for itself: with the sole exception of Hong Kong, all East Asian countries have managed to engineer significant increases in their investment rates. But the evidence on TFP is indirect and has to be interpreted with care. There is in fact a fundamental problem with these estimates of TFPG" According to Rodrik TFPG is calculated as a residual. One implication is that the calculation depends on the maintained hypothesis about the form of the underlying production function which itself is never directly observed. There exists a general theorem due to Diamond et al. (1978), which says that it is impossible to distinguish factor-augmenting technological change from the shape of the production function (and a particular its elasticity of substitution). What this means in our context is that we may be misattributing labour-augmenting technical change in East Asia to an assumed elasticity of substitution that is too high, with the consequence that TFP growth is underestimated. To show this more concrete, we can look at Bosworth-Collins calculation for rates of factor accumulation. Bosworth and Collins assume that the production functions are of the Cobb-Douglass form with capital share (α) of 0.35. They calculated TFPG as follows:

$$\text{TFPG} = (\hat{y} - \hat{l}) - \alpha(\hat{k} - \hat{l}) - (1-\alpha)\hat{h} \qquad (2.5a.1)$$

Where

y = output

l = employment

k = capital

h = skill and hat denotes percent changes

But now assume the true elasticity of substitution is below unity. Then capital deepening would result in the factor share of capital (α) to fall over time than remain constant at 0.35. For given rate of capital deepening and output growth, the residual would correspondingly increase. This effect would be particularly strong in the East Asian countries where the capital deepening has been high. Consequently the downward bias in estimating TFPG would be large for East Asia.

Table (2.5a.5) TFPG for East Asia implied by different assumptions about Factor Substitution

Elasticity of substitution	Implied TFPG after:			Implied factor share of capital after:		
	10 years	20 years	30 years	10 years	20 years	30 years
1.0	1.03	1.03	1.03	0.35	0.35	0.35
0.8	1.28	1.51	1.73	0.31	0.28	0.24
0.5	1.93	2.53	2.89	0.21	0.12	0.06
0.3	2.68	3.17	3.27	0.10	0.02	0.00

Notes: These calculations assume an initial factor share of capital of 0.35, and are based On the Bosworth –Collins result for factor.

The first row of the table shows the annual TFP growth rate, which are slightly over 1% for East Asia on average. The reaming rows display what the imputed TFPG rates would have been under different assumptions about the elasticity of substitutions.

One defence of the unity σ is that we do not actually observe the reductions of α that would be implied by low σ. But this is misleading. (More discussion, see A2.5a)

Further he concludes; it is difficult to discern the relative contribution of accumulation and technical change in East Asian growth. In spite of such difficulty he adds: “However, in my view, neither nihilism nor downplaying the importance of capital accumulation is the right response to this. Capital accumulation itself is relatively well measured, and there is a tight relationship between it and economic growth”. In the end he claims capital accumulation is the proximate source of growth in East Asia. Then he concludes this approach is consistent with both the East Asian and the broader cross-country experience.

However, there is also disagreement among economists about the role of Interventionism, openness and income redistribution policy for high economic performance of East Asia. You can see a summary of this discussion in appendix (See appendix A.2.5a’).

2.5b - Explaining differential in economic performance within East Asia

As I mentioned above, there are different economic performance across the East Asian countries. Such differentials are significant. For example, the Philippines' experience – with a growth rate per worker of 1.2 percent compared to the East Asia average of 4.2 percent- has been decidedly inferior to the other economies'. But even one leaves this country out, we still have the Indonesian and Malaysian cases. These two countries experienced annual average growth rates per worker of 3.4 and 3.8 percent, respectively, over the entire 1960-94 period. It is still about 2 percentage points below the growth experienced by Korea and Taiwan (see table 2.5a.4).

It is clear that the East Asian countries differed from each other in terms of initial conditions, the institutional context, and government policies. These differences have led many to argue that there is no single East Asian recipe for success. It is plausible that many of these differences account for the variation in economic performance in the region as well.

Of course, it is well recognized that institutions have played an important role in East Asian success.

Easterly and Levine's empirical study on eight East Asian countries – Indonesia , Japan, Korea, Malaysia, Philippines, Singapore, Thailand, and Taiwan – shows that there is tremendous variation across the East Asian countries in the ranking of their institutions. Japan, Singapore and Taiwan receive very high grades, while the Philippines scores particularly low. In fact, the Philippines score puts it slightly above a country like Bangladesh. Indonesia scores low, at about the same level as Burma, Congo and Ghana. The remaining countries score intermediate.

Table (2.5b.1) Basic data

Country	Growth of output per worker 1960-94	Log of income 1960	Average years of education 1960	Quality of institution	Ethno-linguistic fragmentation 1960	Gini coeff. C.1960

Indonesia	2.91	1.76	1.60	3.67	0.76	0.33
Japan	4.50	3.41	6.88	9.37	0.01	0.40
Korea	5.10	2.16	4.43	6.36	0.00	0.34
Malaysia	3.15	2.71	2.82	6.90	0.72	0.42
Philippines	1.37	2.44	4.22	2.97	0.74	0.45
Singapore	4.54	2.81	3.25	8.56	0.42	0.40
Thailand	4.24	2.26	3.24	6.26	0.66	0.41
Taiwan	5.22	2.51	3.81	8.24	0.42	0.31

Sources: Bosworth and Collins (1996 for growth rates, income and education). Knack and Keefer (1995) for institution; and Easterly and Levine (1996) for ethno-linguistic fragmentation; Alesina and Rodrik (1994) for Gini coefficients.

These rankings are in line with conventional wisdom on the quality of public institutions across the region. The Philippines is well known for its "crony capitalism" and weak bureaucracy, and Indonesia for its high level corruption. Hence, it would be plausible to attribute the relatively poor performance of these two economies to their weak institutions. At the same time, we are left with the puzzle that Malaysia, whose growth performance was only slightly better than Indonesia, has a much higher score on institutional quality.

These eight countries differed greatly among themselves in their income and education levels in the early 1960s. Differences in educational levels and in convergences effects must have played a role along with institutions, in determining their respective growth paths. Korea, for instance, was the second poorest country in our sample in the early 1960s but also had the second highest level of education. This may help account for its outstanding performance relative to others in the region. In fact, these three variables – institutional quality, initial income, and initial education – do a surprisingly good job of explaining the growth performance of the countries in the region.

Before we continue our discussion about different growth performance in the region, it seems necessary to consider endogenously of our index of institutional. We must know that the quality of institutional index depends on some other variables in a country. Rodrik (1997 regress institutional quality index depends on three indicators for the early 1960s: income, education and ethno-linguistic fragmentation (ELF), as follow:

$$\text{Institutional quality} = 2.63 + 4.82 \log (Y60) - 1.39 (\text{education}) - 6.23 (\text{ELF})$$

(3.09) (1.43) (0.62) (2.26)

Adj. $R^2 = 0.73$ n = 8 (standard errors in parentheses)

The results show that institutional quality increased with income and decreases with ethno-linguistic fragmentation (However, education is negatively correlated with institutional quality, which is difficult to explain). The values of this index for the eight countries of the region are shown in table (2.5b.1). To avoid bias estimation, he uses ELF (along with initial income and education) as an instrument for institutional quality. The result has the same characteristic.

Now we come back to our main theme namely economic growth across East Asia. Table (2.5b.2) below shows the results of regressing measures of economic performance on our three independent variables (initial income, initial education and institutional quality)

Table (2.5b.2) regression Results For East Asian Countries

	Dependent variable:		
	Growth of output per worker	Capital accumulation	TFPG
Constant	4.85 (0.25)	5.07 (1.12)	1.28 (0.67)
log of income ,1960	-3.11 (0.18)	-2.02 (0.83)	-1.26 (0.49)
years of education, 1965	0.38 (0.04)	-0.01 (0.19)	0.22 (0.11)
institutional quality	8	0.65 (0.15)	0.32 (0.09)
n	8	8	8
adj. R^2	0.99	0.72	0.80

Further Rodrik want to explain how well these three independent variables can discriminate between star and average performance in the region. He is satisfied with the results and claims that “all three variables are highly significant in statistical terms” According to Rodrik the coefficient on initial income, suggest very strong convergence effect with the region. The coefficient on institutional quality indicates that a one-point increase on this scale (which goes from 0 to 10) is associated with a 0.8 percent increase in the long- run growth of GDP per worker. The high value of R^2 indicates that three independent variables taken together account for virtually all of the variation in this regression. Table (2.5b.2) also shows the regression results where dependent variables are rates of capital accumulation and TFPG. The values of R^2 are not too high and these are understandable because of ambiguity in the “measurement” of TFPG and in how we partition growth between accumulation and technical change.

Table (3.5b.3) displays the deviation of each country’s growth from the regional average. Taiwan, Korea, Japan and Singapore are the star performers while the Philippines, Indonesia and Malaysia are the laggards. Thailand is somewhere about the average.

The results in table (2.5b.3) can be summarized as follows:

In three of the four star performers (Japan, Taiwan and Singapore) quality of institutions accounts for the bulk of the performance. In fact, the convergence effect was negative (subtracting from growth) in Japan and Singapore, these being the region’s two richest economies in 1960. In the absence of superior institutions Japan and Singapore would have been predicated to grow at rate bellow the regional average.

In the Philippines and Indonesia, it is poor institutions that were primarily responsible for less performance. The convergence effect in Indonesia was strongly positive, but cancelled by poor institutions.

Initial education levels played an important positive role in Japan and a negative role in Indonesia.

It is primarily the convergence effect that accounts for Korea’s good performance. Education appears to have played a positive effect as well, while below-average institutions were a negative force.

We can conclude, on the base of empirical analysis, that Taiwan, Japan, and Singapore have the best institutions and the highest growth rates, the Philippines and Indonesia have the worst institutions and the lowest growth rates; and Thailand, Korea, and Malaysia are intermediate.

Table (2.5b.3): Explaining Diversity in Growth Performance

	Growth of output per worker	Deviation	Contribution of:

	per worker 1960-94	from average	convergence	education	Institution	total	unexplained
Indonesia	2.91	-0.96	2.34	-0.82	-2.38	-0.87	-0.10
Japan	4.50	0.62	-2.81	1.17	2.34	0.70	-0.80
Korea	5.10	1.22	1.07	0.24	-0.15	1.17	0.05
Malaysia	3.15	-0.73	-0.62	-0.36	0.30	-0.69	-0.04
Philippines	1.37	-2.51	0.20	0.16	-2.96	-2.59	0.09
Singapore	4.54	0.66	-0.94	-0.20	1.67	0.54	0.12
Thailand	4.24	0.36	0.77	-0.20	-0.23	0.33	0.03
Taiwan	5.22	1.34	-0.01	0.01	1.41	1.41	-0.08

After all, some questions still remained unanswered: do these economies move towards the same steady state level? Can East Asian region catch-up with more advanced economies in the world? I try to answer these questions and similar problems in the next section.

3- Panel data analysis and estimating the Solow growth model in East Asia

In this part of paper, I will present my own empirical analysis of East Asian economies. Here similar to previous section, we have to present our model, econometric model, first. Then, we can estimate the coefficients of our growth model and find the rates of convergence (both between this region and other part of the world and within the region).
I arrange this part as follows:

Section 3.1 presents a linear dynamic panel data model. Then in section 3.2 we discuss the inconsistency of least squares (when t is finite). In section 3.3 we will look at instrumental variables estimation method. The advantage and disadvantage of panel data will be discussed in section 3.4. In section 3.5 there will be estimating the Solow growth model. Under this section I will present our data, estimating the model and convergence hypothesis (both absolute and conditional convergence).

3.1-Dynamic linear model (panel data analysis)

One of the main advantages of panel data is that it allows one to study the dynamics of economic behaviour at an individual level.
There has been specially attention in panel data literatures, in autoregressive first order model AR (1). This is an equation model where one or more lagged values of left-hand side variable in the model appear as right-hand side variables, either alone or with one or many exogenous variables.
Here, I will present AR (1) model: AR (1) – model with fixed effects and exogenous variables.

AR(1) Fixed Effects model

The autoregressive fixed effect model can be written as:

$$y_{it} = \alpha_i + y_{i,t-1}\gamma + x_{it}\beta + u_{it}\,, \ |\gamma| < 1 \qquad (3.1.1)$$

i = 1, …,N,

t = 1,…..,T,

We assume that the residual satisfy the following conditions:

$$\begin{cases} E(u_{it} \setminus y_{i.t-1}, x_{it}) = 0 \\ V(u_{it} \setminus y_{i.t-1}, x_{it}) = \sigma_u^2 \\ Cov(u_{it}, u_{js} \setminus y_{i,t-1}, x_{it}) = 0 \end{cases}$$ For all i and t and for all i $\neq j$ and t $\neq s$

i.e., the disturbances are uncorrelated with the explanatory variables, are not serially correlated and are homoscedastic.

We also can write, in matrix form, the following model.

$$\underline{Y} = \gamma \underline{Y}_{-1} + X\underline{\beta} + D\underline{\alpha} + \underline{U} \qquad (3.1.2)$$

With

$$\underline{Y} = \begin{pmatrix} y_{11} \\ . \\ . \\ . \\ y_{1T} \\ . \\ . \\ y_{NT} \end{pmatrix} \qquad \underline{Y}_{-1} = \begin{pmatrix} y_{10} \\ . \\ . \\ . \\ y_{1,T-1} \\ . \\ . \\ y_{N,T-1} \end{pmatrix} \qquad X = \begin{pmatrix} \overset{(1)}{x_{11}} & . & . & . & \overset{(k)}{x_{11}} \\ . & . & . & . & . \\ . & . & . & . & . \\ x_{1T} & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & .. \\ x_{NT} & . & . & . & \overset{(k)}{x_{NT}} \end{pmatrix}$$

$$D = I_N \otimes I_T \qquad \underline{U} = \begin{pmatrix} u_{11} \\ . \\ . \\ u_{NT} \end{pmatrix} \qquad \underline{\beta} = \begin{pmatrix} \beta_1 \\ . \\ . \\ \beta_K \end{pmatrix} \quad \underline{\alpha} = \begin{pmatrix} \alpha_1 \\ . \\ . \\ \alpha_N \end{pmatrix},$$

Mathematically equation (3.1.1), for each individual i, is a first-order, linear difference equation. Its solution for period t by initial value of y_{it}, y_{i0} is

$$y_{it} = \gamma^t y_{i0} + \sum_{s=0}^{t-1} \gamma^s (\alpha_i + x_{i,t-s}\beta + u_{i,t-s}) = \gamma^t y_{i0} + \frac{1-\gamma^t}{1-\gamma}\alpha_i + \sum \gamma^s (x_{i,t-s}\beta + u_{i,t-s})$$

i = 1,……,N

t = 1,……,T (3.1.3)

If t $\to \infty$ and $|\gamma| < 1$ so we have:

$$y_{it} = \sum_{s=0}^{\infty} \gamma^s (\alpha_i + x_{i,t-s}\beta + u_{i,t-s}) = \frac{\alpha_i}{1-\gamma} + \sum_{s=0}^{\infty} \gamma^s (x_{i,t-s}\beta + u_{i,t-s}) \tag{3.1.4}$$

(Model with random effects and exogenous variable, see A3.1)

3.2- The Inconsistency of the Least squares with dummy variables (LSDV) within estimator when T is finite

Although the disturbances of the model are assumed to be IID, this model cannot be consistency estimated by OLS as long as the number of period is finite.
The estimation of the coefficients γ and $\underline{\beta}$ can be estimated by applying OLS to the following transformed model

$$W_n \underline{Y} = W_n \underline{Y}_{-1}\gamma + W_n X \underline{\beta} + W_n \underline{U} \tag{3.2.1}$$

Where

$$W_n = I_n \otimes (I_n - \frac{J_T}{T})$$

Then, the OLS estimator of γ and $\underline{\beta}$ can be written as the within estimator:

$$\begin{pmatrix} \hat{\gamma} \\ \underline{\hat{\beta}} \end{pmatrix} = \begin{pmatrix} \underline{Y'}_{-1} W_n \underline{Y}_{-1} & \underline{Y}_{-1} W_n X \\ X' W_n \underline{Y}_{-1} & X' W_n X' \end{pmatrix}^{-1} \begin{pmatrix} \underline{Y'}_{-1} W_n \underline{Y} \\ X' W_n \underline{Y} \end{pmatrix} \tag{3.2.2}$$

Since W_n is a symmetric, idem potent matrix , when N$\to \infty$, one can write:

$$\text{P lim} \begin{pmatrix} \hat{\gamma} \\ \underline{\hat{\beta}} \end{pmatrix} = \begin{pmatrix} \gamma \\ \underline{\beta} \end{pmatrix} + \begin{pmatrix} \underset{N\to\infty}{p\lim} \frac{1}{NT} \underline{Y'}_{-1} W_n \underline{Y}_{-1} & \underset{N\to\infty}{p\lim} \frac{1}{NT} \underline{Y'}_{-1} W_n X \\ \underset{N\to\infty}{p\lim} \frac{1}{NT} X' W_n \underline{Y}_{-1} & \underset{N\to\infty}{p\lim} \frac{1}{NT} X' W_n X \end{pmatrix}^{-1} \begin{pmatrix} p\lim \frac{1}{NT} \underline{Y'}_{-1} W_n \underline{U} \\ p\lim \frac{1}{NT} X' W_n \underline{U} \end{pmatrix} \tag{3.2.3}$$

We also know that

$$p\lim \frac{1}{NT} X' W_n \underline{U} = 0$$
$$N \to 0$$

but

$$p\lim \frac{1}{NT} \underline{Y}'_{-1} W_n \underline{U} = p\lim \frac{1}{NT} \sum_i \sum_t (y_{i,t-1} - y_{i.-1})(u_{it} - u_{i.}) =$$
$$N \to 0 \qquad\qquad N \to 0$$

$$E(\frac{1}{T} \sum_t (y_{i.t-1} - y_{i.-1})(u_{it} - u_{i.})) = -\frac{1}{T^2} \frac{T-1-T\gamma+\gamma^T}{(1-\gamma)^2} \sigma_u^2 \neq 0 \qquad (3.2.4)$$

Then, as long as the number of period is kept fixed, the OLS estimator of an autoregressive fixed effects model is not consistent. This semi-inconsistency is due to the asymptotic correlation that exists between $(y_{i,t-1} - y_{i.-1})$ and $(u_{it} - u_{i.})$ when $N \to \infty$: though $y_{i,t-1}$, and u_{it} are uncorrelated, their respective individual means are correlated with each other, with u_{it} and with $y_{i.t-1}$, and the sum of these three covariance does not vanish.

As it is clear from (3.2.4) , when N and $T \to \infty$, this estimator is consistent since

$$p\lim \frac{1}{NT} \underline{Y'}_{-1} W_n \underline{U} = 0 \qquad (3.2.5)$$
$$N, T \to \infty$$

Hence, if the number of periods in the sample is large enough, the asymptotic bias of this estimator is likely to be rather small.

3.3- Instrumental Variables Estimation Methods (in difference form)

One way to deal the problem of getting consistent estimators when using an autoregressive fixed model is to write the model in first differences form:

First order differences from (3.1.1) and (3.1.4) follows

$$\Delta y_{it} = \sum_{s=0}^{\infty} \gamma^s (\Delta x_{i,t-s} \beta + \Delta u_{i,t-s}) \qquad i = 1,\ldots\ldots\ldots N$$
$$t = 1,\ldots\ldots.;T, \qquad (3.3.1)$$

Equations (3.1.3) and (3.3.1) support that $\Delta x_{i,t-\tau}$ or $x_{i,t-\tau}$ for $\tau = 1,2,.....$ or linear combination of them, satisfied those requirements that we use them as instrumental variables for $\Delta y_{i,t-1}$.

We can write the model as following form:

$$\Delta y_{it} = \Delta y_{i,t-1}\gamma + \Delta x_{it}\beta + \Delta u_{it} \qquad i = 1,\ldots,N \quad t=2,\ldots,T \qquad (3.3.2)$$

$$\left.\begin{array}{l} E(y_{i,t-\tau}\Delta u_{it}) = 0 \\ E(\Delta y_{i,t-\tau}\Delta u_{it}) = 0 \end{array}\right. \quad \text{For all i and t and } \tau \geq 2$$

$$\left.\begin{array}{l} E(X'_{i\theta}\Delta u_{it}) = 0_{K,1}, \\ E(\Delta X'_{i\theta}\Delta u_{it}) = 0_{K,1} \end{array}\right. \quad \text{For all i ,t and } \theta$$

With suitable choice among them we can obtain consistent estimators for γ and β.

Among modification of these methods we can mention the following points:

(i) We can use linear combination of $y_{i,t-\tau}$ and $\Delta y_{i,t-\tau}$ for $\tau \geq 2$ and also $x_{i,t-.\tau}$ and $\Delta x_{i,t-\tau}$ for $\tau \geq 1$ as instrumental variables for $\Delta y_{i.t-1}$.

(ii) We can, instead of operate on (3.3.1), differentiate (3.1.3) over two or many periods. It is also possible to combine such many differentiated variables.

(iii) We also can keep (3.1.4) to its standard level, but use as instrumental variables for $y_{i,t-1}$, back-dated differences of type $\Delta y_{i,t-\tau}$ for $\tau \geq 2$ and $\Delta x_{i,t-\tau}$ for $\tau \geq 1$

Now it is the time to consider a complex use of instrumental variables to estimate AR (1) relation with exogenous variables, which are transformed to growth form.

Equation (3.3.2) for t= 3…T, which existing of T-2 equations, each of them with N observation, can be written as:

$$\left\{\begin{array}{l} \Delta y_{i3} = \Delta y_{i2}\gamma + \Delta x_{i3}\beta + \Delta u_{i3} = (\Delta y_{i2}, \Delta x_{i3})\delta + \Delta u_{i3} \\ \Delta y_{i4} = \Delta y_{i3}\gamma + \Delta x_{i4}\beta + \Delta u_{i4} = (\Delta y_{i3}, \Delta x_{i4})\delta + \Delta u_{i4} \\ \qquad \vdots \\ \Delta y_{iT} = \Delta y_{i,T-1}\gamma + \Delta x_{iT}\beta + \Delta u_{iT} = (\Delta y_{i,T-1}, \Delta x_{iT})\delta + \Delta u_{iT} \end{array}\right. \qquad (3.3.3)$$

i = 1,……,N

Where: $\delta = (\alpha, \beta^{'})'$, or in compact notation:

$$q_i = W_i\delta + u_i \qquad (3.3.4)$$

i = 1,….,N

We want to use this instrumental matrix:

$z_{i2} = (y_{i0}, \Delta x_{i3})$ For $(\Delta y_{i2}, \Delta x_{i3})$ in first equation

$z_{i3} = (y_{i0}, y_{i1}, \Delta x_{i4})$ For $(\Delta y_{i3}, \Delta x_{i4})$ in second equation

.

.

.

$z_{i,T-1} = (y_{i0}, y_{i1}, ..., y_{i,T-2}, \Delta x_{iT})$ for $(\Delta y_{i,T-1} \Delta x_{iT})$ in T-2'Th equation.

We set them together to an instrumental matrix for matrix W_i as follows:

$$Z_i = \begin{bmatrix} z_{i2} & 0 & . & . & . & 0 \\ 0 & z_{i3} & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ 0 & 0 & . & . & . & z_{i,T-1} \end{bmatrix} \text{, i = 1,….,N} \qquad (3.3.5)$$

We set equation (3.3.4) for all individuals under each other for one equation;

$$\mathbf{q} = \mathbf{W}\delta + u \qquad (3.3.6)$$

Where

$$\text{q} = \begin{bmatrix} q_1 \\ . \\ . \\ . \\ q_N \end{bmatrix}, \quad \text{W} = \begin{bmatrix} w_1 \\ . \\ . \\ . \\ w_N \end{bmatrix}, \quad \text{u} = \begin{bmatrix} u_1 \\ . \\ . \\ . \\ u_N \end{bmatrix}, \quad \text{z} = \begin{bmatrix} z_1 \\ . \\ . \\ . \\ z_n \end{bmatrix}$$

$\Rightarrow$

$$\hat{\delta}_{GMM} = \left[W'Z(Z'Z)^{-1}Z'W\right]^{-1}\left[W'Z(Z'Z)^{-1}Z'q\right] = \left[(\sum_{i=1}^{N} W_i'Z_i)(\sum_{i=1}^{N} Z_i'Z_i)^{-1}(\sum Z_i'W_i)\right]^{-1} \times$$

$$\left[(\sum_{i=1}^{N} W_i'Z_i)(\sum_{i=1}^{N} Z_i'Z_i)^{-1}(\sum_{i=1}^{N} Z_i'q_i)\right] \qquad (3.3.7)$$

This method is called General Moment Method (GMM).

3.4-The advantage and disadvantage of panel data

The use of panel data structure in empirical analysis has both advantages and disadvantages.

a-The advantages of panel data

There are some advantages to use panel data structure instead of pure time series or pure cross-section data.

Generally we can record the following points:

(1) Time series data has nothing to say about individual differences.

(2) Cross-section data gives no information about period specific differences.

Thus, we can not use time series data to study the effect of individual specific variable and the same way we can not use cross-section data to study the effect of period specific variable. Further cross-section data cannot be used to analysis dynamic model. We can show this advantage by an example as follow:

$$y_{it} = k + x_{it}\beta + z_i\alpha + q_t\gamma + u_{it} \qquad (3.4.1)$$

$$u_{it} \sim \text{I I D}\,(0,\sigma^2)$$

$$\text{cov}(\text{u}_{it}, q_t) = \text{cov}(u_{it}, z_i) = \text{cov}(x_{it}, u_{it}) = 0$$

Where:

K is constant and β,α, and γ are coefficients.

How can be the situation if we have not panel data?

If there were time series data, equation (3.4.1) could take the following form:

$$y_{1t} = (k + z_1\alpha) + x_{1t}\beta + q_t\gamma + u_{1t} \qquad (3.4.2)$$

From (3.4.2) we cannot estimate individual specific effect, namely α.

If there were pure cross section data, (3.4.1) could take the following form:

$$y_{i1} = (k + q_1\gamma) + x_{i1}\beta + z_i\alpha + u_{i1} \qquad (3.4.3)$$

From (3.4.3) we cannot estimate period specific effect, γ.

But panel data, as I mentioned above, has this flexibility that we can control not only individual specific effect but also period specific effects.

From (3.4.1), if we take differences between equations for individual i in period t and i in period s, it follows;

$$y_{it} - y_{is} = (x_{it} - x_{is})\beta + (q_t - q_s)\gamma + (u_{it} - u_{is}) \qquad (3.4.4)$$

i = 1,….,N ,

t, s = 1,…..T , s $\neq$ t

By such technique we can remove individual effect from our equation, in the same way we can remove period specific effect from our relation

$$y_{it} - y_{jt} = (x_{it} - x_{jt})\beta + (z_i - z_j)\alpha + (u_{it} - u_{jt}) \qquad (3.4.5)$$

i , j = 1,….., N, j $\neq$ i

t = 1, ….T

We can also take more complex transformation to remove both individual specific effect and period specific effect.

$$(y_{it} - y_{is}) - (y_{jt} - y_{js}) = \lfloor (x_{it} - x_{is}) - (x_{jt} - x_{js}) \rfloor \beta + (u_{it} - u_{is}) - (u_{jt} - u_{js})$$

(3.4.6)

i , j = 1,……N t, s = 1,…..T, j $\neq$ i , s $\neq$ t.

There is much other transformation in panel data, which we cannot apply them neither by cross section nor by time series data.

Thus, we can conclude that when we have panel data we can choose:

(i) Both time variation and individual variation;

(ii) Only time variation;

(iii) Only individual variation;

(iv) Neither time variation nor individual variation.

Further more, one significant advance comes from clarifying the difficulties in interpreting the standard cross –section regression. The dynamic panel typically displays correlation between lagged dependent variables and the unobserved residual. The resulting regression bias depends on the number of observation in time and only disappears when that number becomes infinite. Moreover, the bias does not disappear with time average. Thus, if the dynamic panel were the underlying structure, standard cross-section regression will not consistently uncover the time structure parameters.

The panel data structure has been argued, to be, more appropriate for analysing growth dynamics. For instance, Islam (1996) shows how time and country specific can arise when per capita output is the dependent variable instead of output per effective worker. Alternatively, one might view the error structure as a consequence of omitted variables in the growth equation. Panel data allows greater flexibility and, thus reduced possibilities for misspecification. Such possibilities are unavailable to cross-section regression studies.

b-Disadvantages of panel data

Beside advantages, panel data also has disadvantages in empiric analysis, particularly in economic growth model. To realize the potential disadvantages, we consider an example.

$$\log y_i(t+T) - \log y_i(t) = b_0 + b_1 \log y_i(t) + b_2 \log s_{pi} + b_3 \log s_{hi} + b_4 \log(\delta + n_i + x) + u_{it}$$

(3.4.7)

With

$$b_0 \overset{def}{=} (1-e^{\beta T}) \log A(0) + (t + T - e^{\beta T} t)x$$

$$b_1 \overset{def}{=} e^{\beta T} - 1$$

$$b_2 \overset{def}{=} (1-e^{\beta T}) \frac{\alpha_p}{1-\alpha_p-\alpha_h},$$

$$b_3 \overset{def}{=} (1-e^{\beta T}) \frac{\alpha_h}{1-\alpha_p-\alpha_h},$$

$$b_4 \overset{def}{=} -(1-e^{\beta T}) \frac{\alpha_p+\alpha_h}{1-\alpha_p-\alpha_h}$$

Let T=1 and assume that b_0 is a random variable with unobservable additive components variance in t and I.

$$\log y_i(t+1) - \log y_i(t) = \mu_i + \kappa_t + b_1 \log y_i(t) + b_2 \log s_{pi} + b_3 \log s_{hi} + b_4 \log(\delta + n_i + x) + u_{it}$$

(3.4.8)

Constant b_0, in the last equation, is decomposed into economy –specific and time-specific effects;

$$b_0 = \mu_i + \kappa_t$$

Decomposing b_0 is one of disadvantages in panel data analysis. Freeing b_0 so that it can vary across countries and over time can only help a theoretical model fit the data better. Restricting b_0 to be identical across-countries and over time – when in reality, b_0 should differ – can result in a model that is miss specified, thereby lowing confidence that the researcher has correctly identified and estimated the parameters of interest. This advantage of panel data approach applies generally, and is not specific to growth and convergence. But convergence studies, the flexibility from decomposing b_0 into economy specific and time-specific components can instead be problematic, giving rise to misleading conclusions. There might be happened two difficulties: First, note that, equation (3.4.7) implies that A (0)-and thus b_0 through μ_i - forms part of the long –run path towards which the given economy converges.

If the researcher insists that A (0) be identical across-economies, then the researcher concludes convergence to an underlying steady-state path precisely when catching up between poor and rich takes place. By contrast, when the researcher allows A (0) to differ across countries, finding convergence to an underlying steady-state path says nothing about whether catching up occurs between poor and rich. In panel data analysis, it is consider a virtue that the individual heterogeneities A (0) are unobservable, and explicitly modelled as function of observable right-hand side explanatory variables. By leaving free those individual heterogeneities, the researcher give up hope of examining whether poor economies are catching up with rich ones. The use of panel data methods therefore compounds the difficulties in interpreting convergence regression findings in terms of catch up from poor to rich.

For the second scenario, there has been often problem that the panel data regression equation (3.4.8) confront where the μ_i's, the individual specific effects, are correlated with some of the right-hand side variables. One way of solutions to the inconsistency problem drives from transforming equation (3.4.8) to remove the μ_i's. For instance, in the so-called " fixed effects" or within estimator, one take deviations from time average sample means in equation (3.4.8) and then applies OLS to the transformed equation to provide consistent estimates for the regression coefficients. But we must remember that an applying such an individual – effects removing transformation, the researcher winds up analysing a left-hand side variable purged of its long-run (time-average) variation across countries. Such a method, therefore, leaves unexplained exactly the long-run cross-country growth variation originally motivating this empirical research.

The resulting estimates are, instead, relevant only for higher frequency variation in the left-hand side variable: This might be of greater interest for business cycles research than it is for understanding patterns of long-run economic growth across countries. (Steven N. D. and Danny T. Q., 1998)

3.5- Estimating the Solow Growth model

Here, I briefly set out the Solow growth model to be estimated (for more information, see appendix A3. 5). The growth equation we wish to estimate has the following form:

$$\Delta y_{it} = \gamma_t + (\alpha - 1) y_{i,t-1} + x'_{it}\beta + \eta_i + v_{it} \qquad \text{i = 1, …,N and t = 2 ,…,T} \qquad (3.5.1)$$

Where:

Δy_{it} is the log difference in per capita GDP over 5 year period;

$y_{i,t-1}$ is the logarithm of per capita GDP at the start of the period;

x_{it} is a vector of characteristics measured during, or at the start of the period. In empirical applications of the Solow model these include the logarithm of the investment rate (s_{it}), and the logarithm of the population growth rate (n_{it}) plus 0.05, where 0.05 represents the sum of a common exogenous of technical change g and a common depreciation rate (δ).

Among other things, the unobserved country-specific effects (η_i) reflect differences in the initial level of efficiency, while the period specific intercepts (γ_t) capture productivity changes that are common to all countries.

We can write the above model as:

$$y_{it} = \gamma_t + \alpha y_{i,t-1} + x'_{it}\beta + \eta_i + v_{it} \quad \text{for i = 1,..,N and t = 2,…,T} \qquad (3.5.2)$$

Data

For estimating the coefficients and presenting graphs, like many others, I will use The Penn World Tables (PWT). The PWT dataset that I use is version (5.6), last updated May 10th 2000, and the measure of per capita output is labelled RGDPL (Lysperis index). I will mainly examine the East Asian countries and I shall examine some sub-set of these countries also. Moreover, I want to compare economic growth of these counties with some other countries out of the region. For these countries there are data from 1960 to 1992. The dataset is constructed on the basis of information both from national accounts and from a set of benchmark United Nations International comparison programs. The focus of the analysis is on the logarithm of real per capita GDP in these countries over the period 1960 – 1992.

Table (3.5.1) displays real GDP per capita and investment rate and population growth rate (1960-92)

Country	GDP Invest. 1960	GDP Invest. 1965	GDP Invest. 1970	GDP Invest. 1975	GDP Invest. 1980	GDP Invest. 1985	GDP Invest. 1990	GDP Invest. 1992	n
Singapore	1625 11	1845 21.9	3022 38.8	5363 33.9	7063 37.8	8618 37.3	11698 35	12633 36.2	0.018
Korea	898 7	1046 10.6	1677 21.4	2321 23.3	3093 28	4217 28.5	6665 36.9	.	0.02
Japan	2943 26	4464 29.9	7304 39.9	8376 35.2	10068 34.1	11771 31.7	14317 38.7	15095 37.4	0.01
Hong Kong	2231 21.7	3498 23.8	4504 16.8	5627 18.5	8697 23.4	10599 17.4	14854 17.7	16461 19.3	0.023
Taiwan	1255 14	1651 16.8	2185 21.9	3044 25.9	4458 29.1	5449 19.9	8067 23.1	.	0.023
Malaysia	1409 15	1665 17.2	2154 21.5	2668 22	3805 27.4	4146 26.9	5117 29.6	5729 32.6	0.026
Indonesia	641 6.2	603 6.8	715 11.1	955 17.2	1282 18	1651 26.9	1973 28.2	2104 25.3	0.022
Thailand	940 11.3	1134 15.5	1528 18.3	1686 17.4	2180 17.2	2463 16.8	3570 27	3924 29.8	0.027
Philippines	1133 10.9	1243 13	1404 13.3	1625 18.1	1882 19.3	1542 11.3	1761 17.7	1690 16	0.028
U.S.A.	9908 20.7	11638 23.3	12969 20.4	13712 18.5	15311 20.3	16570 22.3	18073 20.3	17986 19.4	0.011
U.K.	6808 17.3	7664 19.2	8527 20.1	9298 17	10161 15.6	11237 17.2	13223 18.5	12740 16.9	0.003
Germany	6569 31.9	7921 32.7	9431 32	10091 25.2	11916 27.1	12535 23.5	14331 25.7	14703 25.3	0.004

3.5a- Estimating the model and convergence between East Asian and some advanced economies

The following table (table 3.5a.1) displays estimated result among East Asian countries (average log of real GDP per capita, logarithm of investment rate and logarithm of population growth for nine East Asian economies) and six other advanced economies (U.S., U. K. Germany, France, Canada and Norway). These estimations based on data from 1960-1990.

(See data in appendix A3. 5a)

Table (3.5a.1) Estimation of Solow model East Asian countries & other advanced economies

Dependent variable is y_{it}

Right-side variables	Estimation	OLS	Between	GLS	IV
	Observation	42	42	42	42
$\log(y_{i,t-1})$		0.90168 (0.252)	0.8781 (0.0219)	0.8856 (0.0134)	0.8856 (0.141)
$\log(s_{it})$		0.02624 (0.0602)	0.4020 (0.1032)	0.0420 (0.0451)	0.0420 (0.0474)
$\log(n_{it} + g + \delta)$		Dropped	-0.03166 (0.1624)	-0.0188 (0.0811)	-0.0188 (0.0853)
Constant		0.9818 (0.2373)	1.0382 (0.1992)	1 (0.157)	1 (0.165)
Convergent rate (λ)		0.020	0.0259	0.024	0.024

Interval between each observation is five years and dependent variable or left-side variable is y_{it}.

As we realise, there are four different estimations, namely OLS, Between, GLS and IV estimates. I have used differences between log real per capita GDP ($\log y_{it} - \log y_{i,t-1}$) and difference between log real per capita GDP and log investment rate (log $y_{i,t-1} - x_{it}$) as instrumental variables.

Results show that estimated coefficients by GLS and IV are alike. But results between OLS and between estimates are different. These results clearly indicate that convergent rates are low. OLS gives a predicted rate of convergent of 2% per year. At this rate, East Asia (as average) would go halfway toward the same steady state value with advanced economies in34.6 years. Between, GLS and IV estimates indicate shorter times, 25.7, 28.8 and 28.8 years respectively.

I am not sure these instrumental variables, which I have used here, give unbiased results. There are high probabilities that these instrumental variables have some correlation with residuals. Despite such uncertainty, we can claim that it takes a long time for East Asian economies as an Economic unite to achieve the advanced economies level.

Table (3.5a.2) shows the estimated results between four “Asian Tigers” and six industrialised countries.

These estimates are not far from the estimates above, there are slightly different. Table (3.7a.2) shows convergence rate lies between (2-3)% per year. It means if we base our analysis on OLS it will take 31.5 years for halfway, but if our departure point is GLS or IV it will take 25.5 years for halfway. These results seem reasonable because average estimations have been strongly effected by Japan and four tiger’s economies.

Table (3.5a.2) Estimation of growth model for East Asian Tiger & advanced Economies.

Dependent variable is y_{it}.

Right-side Variables	Estimation	OLS	Between	GLS	IV
	Observation	66	66	66	66
$\log(y_{i,t-1})$		0.8943 (0.0307)	0.8623 (0.0239)	0.8717 (0.0164)	0.8717 (0.0169)
$\log(s_{it})$		0.1509 (0.0524)	0.1844 (0.0932)	0.1752 (0.03938)	0.1752 (0.0406)
$\log(n_{it} + g + \delta)$		Dropped	0.23211 (0.1804)	0.2431 (0.1057)	0.2431 (0.1091)
Constant		0.6980 (0.022)	1.469 (0.2883)	1.445 (0.2429)	1.4458 (0.2506)
Convergent rate (λ)		0.022	0.029	0.027	0.027

It is not easy to judge which of these estimations explain the economic reality best. In spite of such uncertainty it seems that GLS and IV estimates are more robust. We must remember that standard errors of IV and GLS are lower than standard errors of OLS and " Between". Besides the estimation results, we will see some graphic presentation.

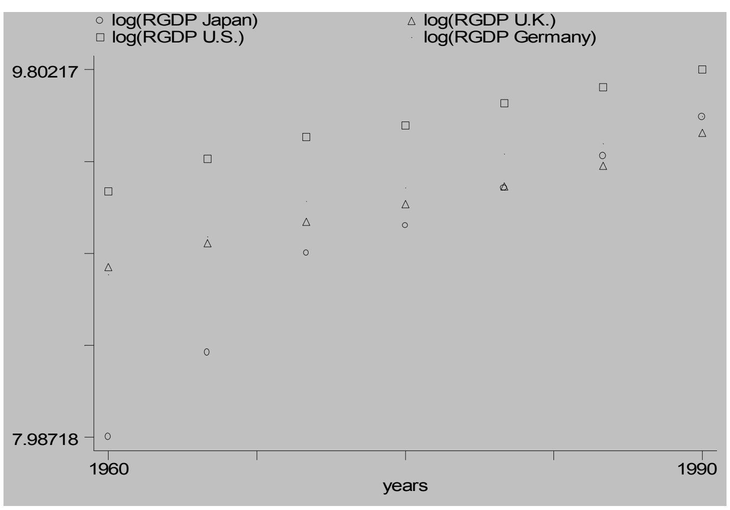


Figure (3.5a.1)

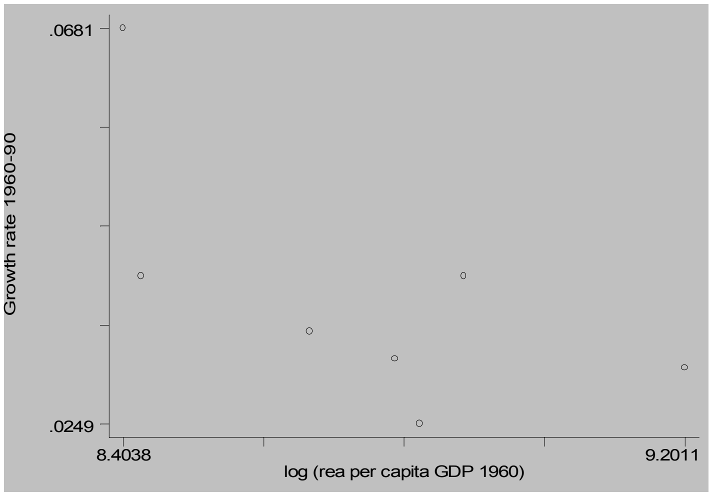


Figure (3.5a.1')

Figure (3.5a.1) displays clearly that real GDP per capita of Japan have moved toward the level of other most advanced economies. Figure (3.5a.1') displays growth rate versus log real per capita income in 1960 among G-7 countries. Both figures indicate that β convergence holds for G-7 countries (between Japan and advanced economies).

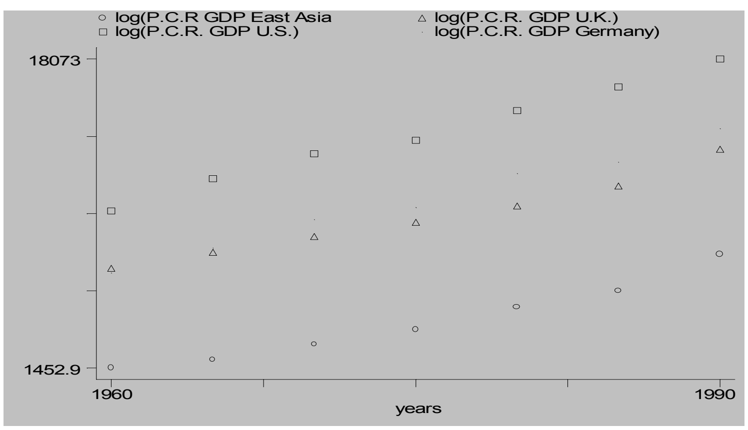


figure (3.5a.2)

Graph (3.5a.2) displays between East Asian economies and three advanced economies in the world (U.S. U.K. and Germany). It looks log real per capita GDP of East Asian economies (as average) move parallel to log real per capita GDP of other and there are no sign of common level in long- run. Hence, absolute β convergence does not apply for East Asian and advanced economies. Figure (3.5a.2') confirms again such conclusions.

Using average data of East Asian countries cannot explain the economic reality. Heterogeneity among these countries is significant. Some countries in the region have remarkable lower saving rate than advanced economies in the world, for instance, average saving rate of Philippines (1960-90) is as half as saving rate of Germany, 14.3 versus 28.73. According to our model, only homogenous economies with the same parameters, particularly the same saving rate, should converge to the same steady state and providing β convergence. Otherwise, we would have conditional convergence. It means economies with different parameters converge to different steady states as explained in section (2.1.d)

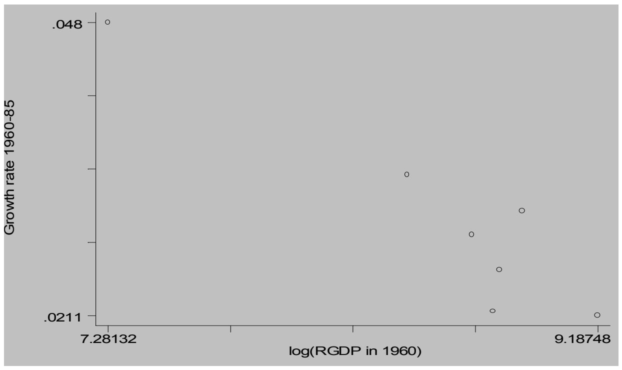


Figure (3.5a.2')

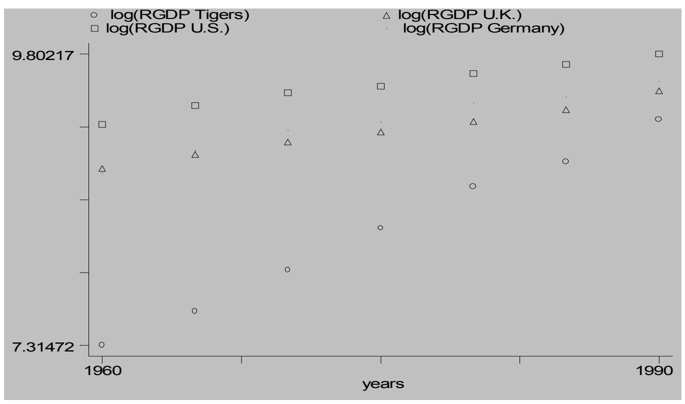


Figure (3.5a.3)

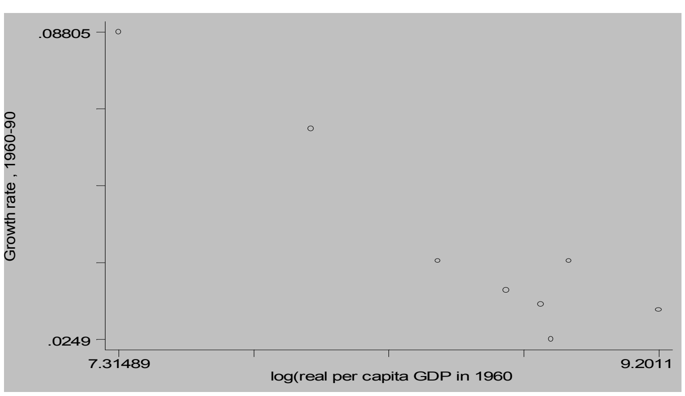


figure (3.5a.4)

Figure (3.5a.3) displays growth rate versus initial level of real per capita GDP, between "Asian- tigers" and G-7 countries. This graph clearly supports convergence hypothesis. In this figure the average growth rate of real per capita GDP from 1960 to 1990 is negatively related to the logarithm of real per capita GDP in 1960. If we assume production functions are the same, then it remains to look at the parameters. The average saving rate of "tigers" is 22.9 which lies between average saving rates of Germany (with 28.7) and U.K. (with 17.7). So we can claim that tigers have almost as high saving rate as G-7 has. Hence, absolute β convergence applies for G-7 countries and "Asian tigers"

Figures (3.5a.5) and (3.5a.6) display long-run real per capita GDP among some "non-tigers" East Asian countries and other Asian countries. Graphic presentations indicate that some "non tigers" in East Asia have the same steady state as some the other countries out of the region.

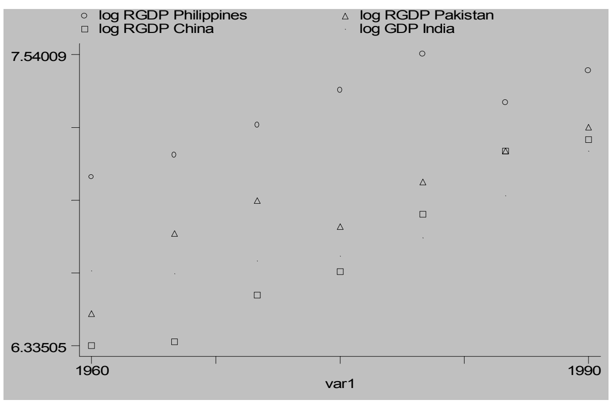


Figure (3.5a.5)

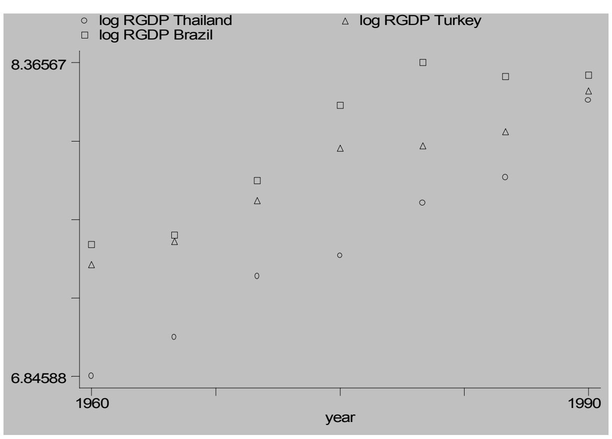


Figure (3.5a.6)

Therefore it seems reasonable to claim that some East Asian countries can converge with other economies out of this region and it seems unlikely to converge among them. In the next section we will look at this question.

3.5b-Estimating the model and convergence among East Asian countries

Analysis of convergence among East Asian countries is presented in the following tables. This estimation based on data from 1960 to 1990. (See data and estimation's results in detail in appendix A3. 5b). Interval between each observation is five years and dependent variable is y_{it}.

Table (3.5b.1) displays estimated coefficients for all nine East Asian countries. The first column of the table contains OLS estimations and second column includes OLS fixed effect. As we see the results of both columns are the same.

Table (3.5b.1) Estimation of the Solow growth model in East Asian countries. Dependent variable is log y_{it}

Independent variable	Estimation	OLS	OLS (Fe)	Between	GLS	IV (z , x1)	IV (z z1 z2)
	Observation	54	54	54	54	54	54
Log($y_{i,t-1}$)		0.8918 (0.0482)	0.8918 (0.0487)	1.033 (0.1127)	0.9773 (0.03839)	1.0362 (0.250)	0.9773 (0.0399)
Log(s_{it})		0.155 (0.6756)	0.1529 (0.06839)	0.1087 (0.237)	0.12918 (0.0664)	Dropped	0.1291 (0.0690)
Log($n_{it}+g+\delta$)		dropped	0.0267 (0.0571)	0.08644 (0.21188)	0.0237 (0.0560)	0.0294 (0.0595)	0.0237 (0.0582)
Constant		0.7040 (0.2959)	0.7092 (0.3247)	-0.1069 (0.5997)	0.0429 (0.2490)	0.0429 (0.2490)	0.1059 (0.2397)
Convergence rate (λ)		0.022	0.022		0.00459		0.00459

Standard errors have bee written in parenthesises, and results shows that standard errors are not too high. But we must remember that OLS estimate in this case cannot produce a consistent estimation because of correlation between right side variables and residual. Convergence rate is almost 2% a year At this rate, these economies would go halfway toward the same steady state in 34.5 years. But convergence rate in GLS and IV estimation (column four and five) are too small that one almost can conclude these economies do not converge to the same steady state. Graphic presentation also indicates almost the same conclusion. The IV results do not seem to be robust either, because of unsuitable instrumental variables. Here, z = $y_2 - y_1$ $z_1 = x_1 - x_2$ and $z_2 = y_1 - x_1$ have bee used as instrumental variables, if y_1 and x_1 have correlation with residual, so our instrumental variables can not be uncorrelated with residual.

Table (3.5b.2) displays results for four East Asian countries so called "East Asian Tigers". These countries have had very high economic performance during the last three decades. OLS estimation gives 10% convergence rate per year, which is very high, and it will take 7 years for these economies to go halfway toward the same steady state value. But IV estimations give different results. Here, I have used two different sets of instrumental variables; therefore we have IV1 and IV2. In IV1 instrumented variable is y_1 but in IV2 instrumented variable is x_1 and the value of z_1, z_2 and z_3 are $y_2 - y_1$, $y_1 - x_1$ and $y_2 - x_1$ respectively.

Both GLS and IV1 give 5.5% convergence rate per year, it means " East Asian Tigers " need almost 12.5 years to go halfway toward the same steady state level. IV2's results are not too far from OLS's results, according to this method after 8 years these economies go halfway toward steady state.

It seems GLS and IV1 give better estimates, particularly when we consider graphic presentation of these countries. Graphic presentation shows these economies are far from the same steady state.

Table (3.7b.3) contains estimated results for "non-tiger" countries such as Indonesia Malaysia, Philippines and Thailand.

What do these numbers tell us?

OLS gives us (1.68)% rate of convergence per year, it means time for halfway is 41 years. This result indicates that these economies are little homogenous.

Table (3.5b.2) East Asian Tigers. Depend variable is log (y_{it})

Right-side Variable	Estimation	OLS	Between	GLS	IV1	IV2
	Observation	24	24	24	24	24
log ($y_{i,t-1}$)		0.6013 (0.2554)	1.0334	0.7560 (0.1895)	0.7560 (0.207)	0.6258 (0.3484)
log (s_{it})		0.7161 (0.3828)	0.5884	0.6258 (0.31812)	0.6258 (0.3484)	0.7560 (0.2076)
log($n_{it} + g + \delta$)		dropped	-3.0779	-2.367 (3.4166)	-2.367 (3.742)	-2.367 (0.742)
constant		1.620 (1.573)	-9.790	-5.790 9.227	-5.790 (10.107)	-5.790 (10.107)
Convergence rate		0.101		0.055	0.055	0.093

GLS and IV estimation give even smaller numbers, 0.5%. Such result almost rules out economic convergence among "non-tiger" East Asian countries. According to our model this result does not seem unreasonable. If we compare saving rate among these countries, we soon recognise that saving rate among these countries are not the same. For example the annual saving rate (as average) of Philippines (19960-90) has been 14.3, which is much lower than Malaysia's saving rate, almost 21.6 per year. Hence, absolute β convergence does not apply for "non-tigers" countries in East Asia.

Table (3.5b.3) East Asian “non-tigers“ countries. Dependent variable is log (y_{it})

Right-side variables	Estimation	OLS	Between	GLS	IV
	observation	24	24	24	24
$\log(y_{i,t-1})$		0.9194 (0.1277)	-0.4575	0.9737 (0.1071)	0.9737 (0.1174)
$\log(s_{it})$		0.11103 (0.1329)	2.4114	0.1117 (0.1258)	0.117 (0.1378)
$\log(n_{it} + g + \delta)$		Dropped	3.8742	-0.8084 (0.9469)	-0.80849 (1.037)
Constant		0.5041 (0.7106)	14.208	-2.026 (3.034)	-2.0265 (3.034)
Convergence rate (λ)		0.0168		0.00533	0.00533

But, if we take OLS, as our departure point, it takes almost 41 years to go halfway. We must remember that OLS does not give a consistent result, and moreover, because of different saving rates, our model almost rules out absolute convergence among them.

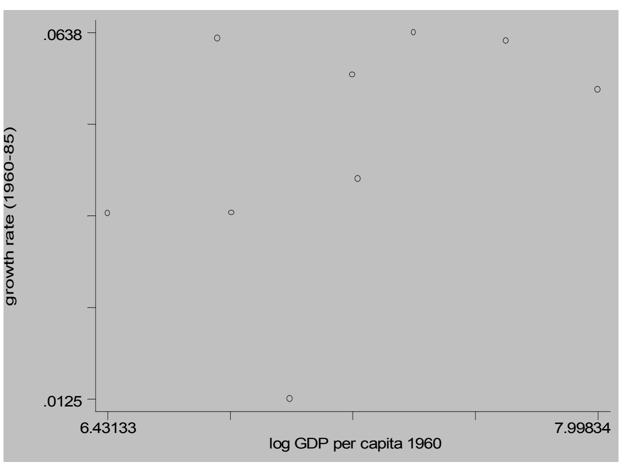


Figure (3.5b.1)

Convergence of GDP across East Asian countries: growth rate versus initial level of real per capita GDP for 9 East Asian countries.

Figure does not indicate any convergence among these countries.

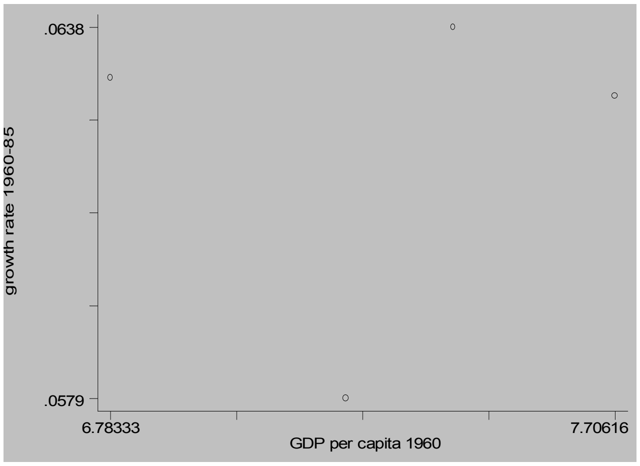


Figure (3.5b.2)

Convergence of GDP among four tigers (Singapore Hong Kong, Taiwan and South Korea): Growth rate versus initial level of real per capita GDP.

There is a weak sign of convergence among these four countries, but figure strongly indicates convergence between Hong Kong and Singapore in one side and between Korea and Taiwan in other side.

Figure (3.5b.3) shows us convergence among Thailand, Indonesia. Malaysia and Philippines. We can easily recognise that Malaysia with high initial real per capita GDP and high average growth (the point lies north-east of figure) can not be counted as a member of this group Thailand (the point lies little above of centre) also differ from Indonesia and Philippines which lie almost on a straight line negative slopped. Hence, only Philippines and Indonesia seem to move toward the same steady state level.

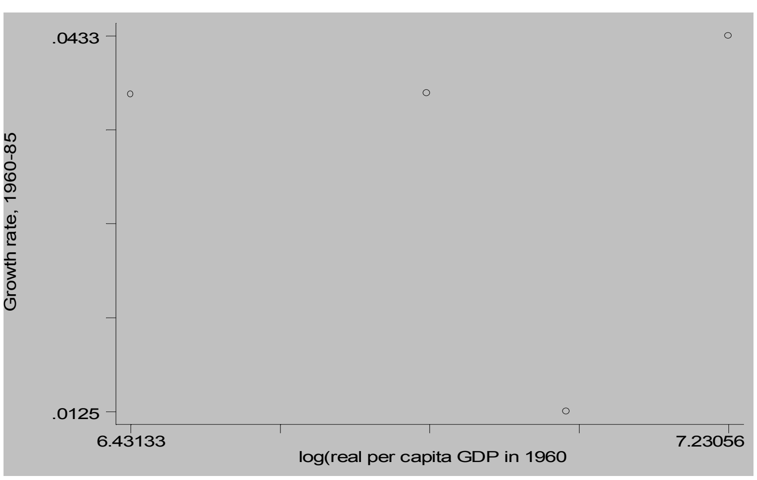


Figure (3.5b.3)

Our model also supports this result, as I mentioned above, since "non-tiger" countries do not have the same saving rate, so they cannot achieve the same steady state. But among them Philippines and Indonesia have the same average saving rate during 1969-90, almost 14.3 percent per year. If we assume the same production function for these two countries, since they have the same parameters, particularly the same saving rate, so absolute β should apply for these two economies. And figure (3.5b.3) shown that they do converge.

Figure (3.5b.4) displays real per capita GDP for Korea, Malaysia, Japan and Hong Kong. Real per capita GDP of these countries move toward the same level.

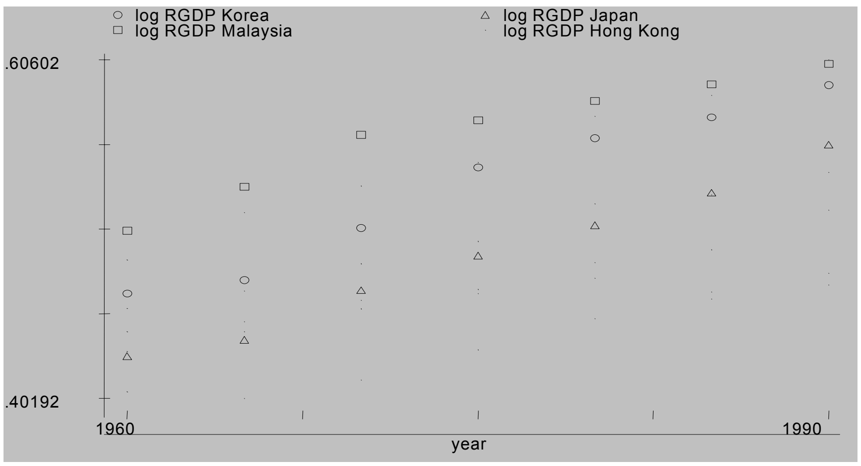


Figure (3.5b.4)

Figure (3.5b.5) shows log of real per capita GDP for "Asian tigers". Log real per capita GDP of these countries do not go toward the same level.

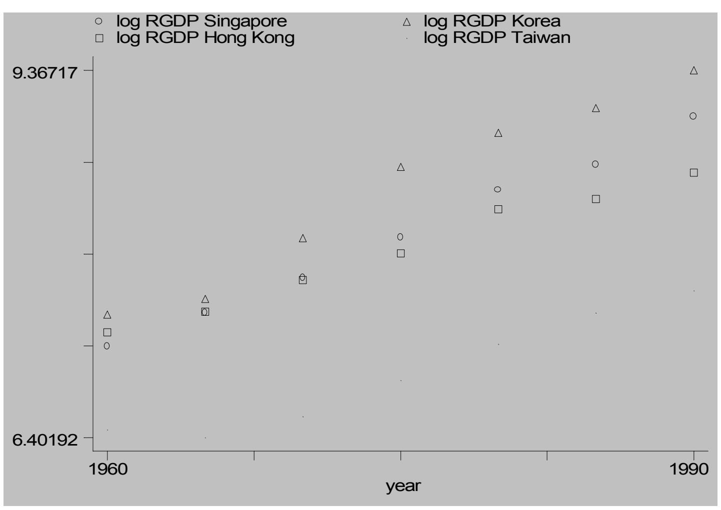


Figure (3.5b.5)

Figure (3.5b.6) displays real per capita GDP for “non-tiger” economies. Real per capita GDP tend to diverge.

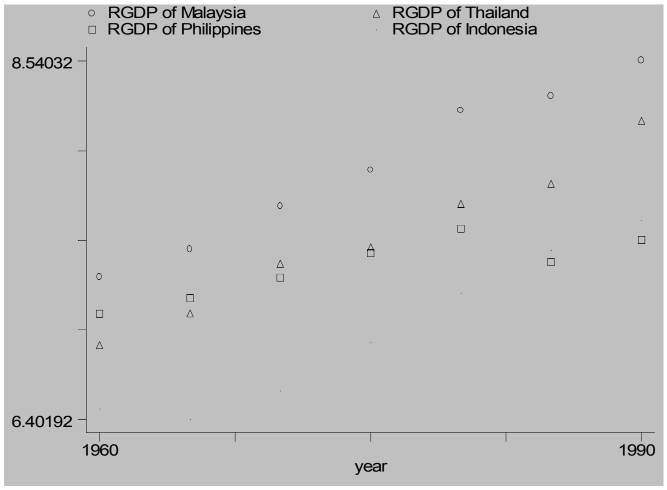


Figure (3.5b.6)

4.Summary and conclusion

This essay presents an economic growth theory, the so- called Solow-Swan model. Its properties and different specifications. Then I examined some critiques of neoclassical model (by Mankiw), among them we observed that our model is based on some strong assumptions such as homogenous production function and an exogenous rate of technological change. The growth model does not give credible quantitative prediction. Solow-Swan model runs into trouble if we turn from qualitative to quantitative prediction. The High Performance Asian Economy (HPAE) is a controversial case among economists. I reviewed briefly relevant literatures in this case, with particular emphasis around two main points: causes of high economic performance as a region in the world, causes of economic success as a country in the region. I presented Krugman, Young and Rodrik's studies in same detail. Young emphases on labour and improving labour's quality as main factor for the economic success of East Asia, but Rodrik believes capital accumulation and technical changes have secured such high economic performance in East Asia. Furthermore within the region he believes three factors – initial education, initial income and quality of institutional – have been main causes for high growth.

In section 3 – the second main part of paper- before carrying out my own empiric analysis, I had to present our econometric model. First I presented dynamic linear model of panel data its properties, we also examined our model both in scalar and in matrix form, and then I consider consistent problem and estimating methods. We examined further some considerations about the model like advantage and disadvantage of the model. I pointed out that although panel data model makes some difficulties for convergence hypothesis but it is more realistic and estimates more consistent coefficients than cross-sectional or time-series analysis does it.

Then we had our growth model in stochastic form and empirical analysis, which has been carried out by myself. As we remember I carried out my empirical analysis, corresponding to theoretical analysis, in two levels: First I compared East Asia with some advanced economies in the world and tried to show whether the economy of region can converge to the advanced economy or not, if it converge how long time this economy need to catch-up others' level. Second I did the same analysis within the region. I carried out my empirical

estimation through different methods like OLS, GLS and instrumental variables (IV). Beside that we also saw through the graphic presentation both among East Asian countries and among some countries of the region and some countries out of the region.
Nonetheless we can conclude the following points:

1- Despite the some weaknesses of neoclassical growth model, unrealistic assumptions and unrealistic predictions on quantitative measures, this model still can be useful in empirical analysis.
2- Both theoretical and empirical analyses in East Asian countries indicate that HPAE has been occurred not only by input-driving growth but also efficiency growth.
3- Average growth rate of East Asian region does not clearly tend to catch-up the level of advanced economies in the World, and further empirical studies shows that there is too much disparity among these countries, so it is difficult to consider them a single economic success.
4- Both theoretical and empirical analysis ruled out absolute β convergence among East Asian countries.
5- My empirical analysis shows that "Asian tigers" countries, as star-performance in the region, converge rapidly both among themselves and with some the most advanced economies in the world. Hence, we can claim absolute β convergence in these cases.
6- In empirical analysis, by different estimating methods we achieved different results. it seems that OLS does not give consistent coefficients. There are some grads of correlation between right-side variables and standard error in our model. The results by IV can not be robust either, because of the same problem. Off course, we could get more consistent results, If we have had more observations and we used better instrumental variables.

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